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ABSTRACT

The National Institute on Aging (NIA) has, for the past several years, focused attention on a wide range of clinical problems associated with aging, including falls and gait disorders, bone fractures, urinary incontinence, and hypertension. Understanding the causes of and exploring possible treatments for Alzheimer's disease has been another of the institute's high-priority areas. Institute-sponsored research on the mechanisms of aging has focused on molecular genetics. Another important area in which the NIA has actively supported research is that of the ways in which psychological and social processes interact with physical processes in older age. The following are some highlights of recent NIA-supported research: transplanted brain cells enhance memory and reverse learning deficits in animals, increased calcium concentrations boost learning in aged rats, high blood pressure is linked to memory impairment, increased periods of chronic illness accompany longer lifespans, living alone does not lead to isolation for many older people, early retirement is influenced by type of occupation, older people hear better using touch, and human factors research offers practical approaches to everyday problems of older people. (MN)

RESEARCH ADVANCES IN AGING 1984–1986

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INTRODUCTION

Understanding aging has become a medical and social imperative for this century. Today, approximately 12 percent of our population is over 65; by the year 2025, this will grow to 20 percent. Such a major demographic shift requires that we make profound changes in our system of health care, in our methods of educating and training medical and other types of caregivers, and in our ability to provide rewarding roles for the increasing numbers of people who remain vigorous longer.

The major scientific questions about human aging—What are the normal consequences of aging? Why do they occur? What can be done to prevent or overcome debilitating diseases in older people? —still remain to be answered in full. But through the efforts of the National Institute on Aging (NIA) more is known today than ever before about this area of human development.

In the past several years, the NIA has focused attention on a wide range of clinical problems, such as falls and gait disorders, bone fractures (including causes, treatments, and prevention strategies), urinary incontinence, and hypertension, all areas in which treatments and interventions are within our grasp. Progress in the clinical handling of these and other medical problems will improve enormously the quality of life for millions of older adults.

An aggressive attack by the NIA on perhaps the most devastating disease associated with old age, Alzheimer disease, has given hope that treatments may one day be available for those who suffer from this form of mental impairment. The establishment in 1984 and 1985 of 10 centers for Alzheimer research marks the beginning of exciting progress in this area. Advances in understanding Alzheimer disease—the highest research priority of the Institute—are discussed in a number of NIA progress reports on this topic.*

Another priority area concerns understanding the most basic mechanisms of aging. The NIA is focusing attention on molecular genetics, utilizing new, powerful research techniques to identify and isolate genes responsible for age-related diseases and to investigate the genetic basis for differences in aging. Scientists working in the newly established NIA Laboratory of Molecular Genetics will search for genes involved in aging processes, examine the molecular basis for the age-dependent decline in immune function, and investigate alterations in the expression of certain genes which may play a role in Alzheimer disease.

NIA-supported research continues on the ways in which psychological and social processes interact with physical processes in old age. Particular emphasis is being placed on the "oldest old" in our society, those 85 years and older. Studies on the unique social conditions of this population will help guide policy makers and others in changing the social structure to accommodate their needs. Other studies attempt to define characteristics of both healthy and ill older persons and to identify behavioral and gender factors that either promote or hinder effective functioning in later life. To these ends, a major focus of the NIA is developing training mechanisms for physicians, other health care providers, and scientists concerned with aging.

Collecting and evaluating data on health and illness is an important part of any comprehensive study of aging. The NIA recently published a *Resource Data Book**

*Copies of NIA publications on Alzheimer disease and the *Resource Data Book* can be obtained by writing to the NIA Information Center, 2209 Distribution Circle, Silver Spring, MD 20910

providing baseline, descriptive data on over 10,000 community-dwelling older individuals from East Boston, Massachusetts; New Haven, Connecticut; and Iowa and Washington Counties, Iowa. Information on demographic characteristics, chronic conditions and impairments, health-related behaviors, and use of medical services is included in this volume.

In addition to its support of research and training in universities and similar settings nationwide, the NIA conducts laboratory and clinical research at its Gerontology Research Center (GRC), located in Baltimore, Maryland, and at the Clinical Center of the National Institutes of Health in Bethesda, Maryland. A long-term study of aging, the Baltimore Longitudinal Study of Aging, was initiated at the GRC in 1958. In this study, repeated observations of the same individuals are made every 2 years so that researchers can learn what happens as people age. This study is already helping to differentiate between changes that are due primarily to aging and those attributable to disease or environmental influences.

The ultimate goal of all research on aging is to improve the quality of life in the later years and to reduce the impact of age-related disabilities and diseases. Yet this goal does not mean that only those individuals 65 and older will be affected by the results of aging research. To bring about significant improvements in the health of future generations, people of all ages must make changes in their lifestyle, diet, and personal health care practices. Studies conducted and supported by the NIA will help define these changes.

Thus, the NIA has both a broad range of research topics to address and a diverse population to serve. This report highlights a few of the areas where recent progress has been made.

Transplanted Brain Cells Enhance Memory and Reverse Learning Deficits in Animals

During the past few years, investigators around the world have successfully transplanted brain tissue from one animal to another. With support from the NIA, Dr. John Sladek Jr. and his colleagues at the University of Rochester in New York have begun to study the ability of transplanted nerve cells to restore or enhance memory in aged rats.

The investigators compared three groups of animals: 3-month-old rats, 26-month-old (or aged) rats, and 26-month-old rats that had received surgical grafts of young healthy brain tissue containing norepinephrine. Norepinephrine is one of several neurotransmitters known to affect memory. On a test of the rats' memories, the normal aged rats performed poorly, but the aged rats hosting the grafts performed much like the younger animals. According to the investigators, these animals exhibited "perfect memory" 24 hours after training.

The brain may be the ideal host for transplanted tissue. The blood-brain barrier is so efficient in its role as the brain's protector that it keeps out antibodies which normally gather at the site

of a foreign substance in other parts of the body. To a certain degree, however, the aged brain presents more of a challenge to investigators. The success of a transplant depends upon the brain's ability to form new communication pathways quickly and efficiently. Studies by Dr. Sladek and others suggest that the aged brain does have this flexibility.

Dr. Sladek's future studies will focus on the long-term survival of grafted tissue in older animal brains. Clearly, the age of the donor is more important than the age of the recipient and, at least in Dr. Sladek's studies, the age of the recipient does not preclude success. If this continues to prove true, then such studies may have important implications for preventing memory loss and for treating Alzheimer disease and other diseases of aging.

Another recent study in this area, conducted by Dr. Fred Gage (currently at the University of California in San Diego) and his colleagues at the University of Lund in Sweden, indicates that brain tissue transplants can reverse learning deficits in severely impaired aged animals. Using a technique perfected by Drs. Anders Bjorklund, Ulf Stenevi, and their collaborators, Dr. Gage hopes to show that the brain can recover from serious damage caused by such neurological disorders as Alzheimer disease. His work has two primary goals: to understand the basic mechanisms underlying loss of memory, hearing and visual deficits, diminished coordination, and other functional impairments that often occur in aging, and to pursue therapies to ameliorate these deficits. In order to do this, Dr. Gage is developing experimental animal models for human disorders.

The studies involve first correlating the behavioral deficits seen in a population of aged rats with selective biochemical and anatomical changes in the brain. In stage two, the investigators are attempting to reverse the anatomical, biological, and behavioral changes by transplanting cells from healthy young rat brains into those regions of the brains of aged animals that control specific functions. Both before and after the transplant operation, the rats are tested on a variety of behavioral tests to measure changes in their performance.

The researchers have found that embryonic rat cells survive and grow in the brains of aged rats. They are also finding that severe motor impairments observed in aged rats can be reversed by transplanting dopamine-containing nerve cells into the striatum. The striatum is an area of the brain responsible for programming motor behavior. Perhaps the most exciting results, however, have come out of their recent study of cognitive deficits. Dr. Gage and his colleagues have been able to reverse serious learning deficits in impaired aged rats by transplanting cholinergic cells into the hippocampus. The hippocampus is involved in the formation, retrieval, and consolidation of memory. In humans with Alzheimer disease, the hippocampus shows marked cell pathology.

Before the transplants, some of the aged rats showed severe impairments on a task of memory and learning. Three months after the transplants, these rats were able to learn the strategy required to complete the task successfully.

Through experiments like these, researchers are learning a great deal about specific neurochemical systems as they relate to behavior. There is also a good deal of excitement among researchers about the fact that transplanted brain tissue can survive and thrive in a foreign host. Perhaps some day, these studies

can be applied to help us understand and treat dementia and related neurological disorders in the human population.

Normal Brain Aging and Dementias of Old Age are Focus of NIA Studies

The NIA's Laboratory of Neurosciences (LNS), located at the NIH Clinical Center in Bethesda, Maryland, is making significant contributions towards our understanding of the fundamental processes which underlie normal brain aging and the dementias of aging. Using positron emission tomography (PET), a technique used to study brain metabolism and function, and various neuropsychological measures, these scientists are exploring how brain function, and perhaps most significantly cognitive function, is tied to metabolic activity in the brain. PET uses a chemical analogue similar in structure to glucose to monitor metabolic activity in different regions of the brain. Glucose, or sugar, is the main source of the brain's energy. A radioactive positron-emitting label on the chemical allows specific areas of the brain to be visualized by computerized image-processing.

LNS scientists were the first to find that brain metabolic activity does not decline over the life course and that the healthy aged brain is as active as the healthy young brain.* They were also the first to report that glucose is used excessively in brains of young adult Down syndrome patients (see below).

More recently, LNS scientists have begun to use PET to measure cerebral metabolism in patients with mild, moderate and severe forms of Alzheimer disease, and are attempting to compare their results with neuropsychological performance. It is well established that there are considerable changes in cerebral metabolism in late stages of Alzheimer disease, but not so well established what, if any, changes in metabolism precipitate changes in cognitive function in early stages. NIA scientists are attempting to develop a fuller picture of the disease by studying patients during the earliest detectable stages of the diseases.

One exciting avenue being pursued involves study by Drs. Barry Horowitz and Timothy Soncrant of how the brain is organized in terms of function. For example, in young adults there is a strong correlation between the activity of the frontal and parietal lobes. LNS scientists are finding some differences in communication between these brain regions as people age. In the upcoming years, these investigators will attempt to refine and broaden application of this novel matrix approach to understand brain function in aging and dementia.

NIA Studies Brain Metabolism in Down Syndrome Patients

An NIA study suggests that brain glucose utilization is elevated by 30 to 40 percent in young adults with Down syndrome. This syndrome is the most common form of mental retardation with a known cause. Down syndrome patients older than age 35 frequently show the mental symptoms of Alzheimer disease.

Dr. Stanley Rapoport, an intramural scientist with the NIA's Laboratory of Neurosciences, working with the cooperation and assistance of the National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases

*Further details on this topic are available in the NIA's *Special Report on Aging 1983* see inside back cover for ordering information

and the Nuclear Medicine Department of the Warren G. Magnuson Clinical Center, NIH, measured brain metabolism in four Down syndrome patients younger than 35 years of age, in one 51-year-old patient, and in healthy age-matched volunteers. Measurements were performed under resting conditions by means of the PET technique, focusing on metabolic activity in the cerebral hemispheres, the upper portions of the brain which are responsible for thought processes, organized motor behavior, sensation, speech, and hearing.

The results revealed a higher level of glucose metabolism in the brains of the four younger Down syndrome patients (ages 19 to 27) than in healthy subjects of the same age, suggesting that the mental retardation of Down syndrome may be associated with a metabolic alteration in the brain. The investigators also looked at a 51-year-old Down syndrome patient and found that glucose utilization was lower than in the younger Down syndrome patients. The current findings thus suggest that brain activity declines as patients with Down syndrome age, in contrast to the situation in normal aging wherein previous laboratory studies had demonstrated no change. The findings are also consistent with recent evidence that brains from older patients with Down syndrome frequently exhibit the nerve cell degeneration and reduced activity of enzymes characteristic of Alzheimer disease.

Although the NIA scientists are cautious about drawing conclusions from their results, their findings clearly indicate the utility of the PET technique for assessing brain function in Down syndrome, Alzheimer disease, and other diseases.

Natural History of Dementia is Examined

NIA epidemiologists are working with investigators at Harvard Medical School and Brigham and Women's Hospital on a study entitled "The Natural History of Senile Dementia" being conducted among the older residents of East Boston. The Harvard investigators include Drs. Denis Evans, Paul Sherr, Marilyn Albert, Harris Funkenstein, and Charles Hennekens. The fundamental purpose of the study is to estimate the frequency with which the various types of dementia occur in this study population aged 65 and older, and then to define usual patterns of disease development over a 3-year period of observation. So far, estimates of the prevalence of cognitive impairment and dementia have been two to three times higher than has usually been reported in prior studies, and over 80 percent of these have been attributed to Alzheimer disease. It is not clear if these high rates reflect an unusual susceptibility to Alzheimer disease among the elderly of East Boston, or if they are due to the special methods for case finding being used in this study. Very few of the cases had been recognized or diagnosed prior to this study, the impaired cognition being previously attributed to aging. Thus far the most usual course appears to be one of only mild continuing declines in cognitive functioning, although there appears to be a greater risk of dying among affected as compared with unaffected persons of comparable age.

Researchers Design Tests to Refine Assessment of Mental Performance

Mental deterioration is one of the most feared problems of old age. Yet studies of "normal" versus pathological deterioration have been few. The NIA's Epidemiology, Demography, and Biometry Program is working with intramural investigators Drs. Robert Garrison and

W: iam Castelli of the National Heart, Lung, and Blood Institute and contract-supported researchers Drs. Edith Kaplan, Philip Wolf, and William Kannel at Boston University to analyze data previously collected on over 2,000 persons in the Framingham Heart Study and to allow continued study of selected groups using neuropsychological tests and neurological examinations. Such tests measure specific mental capacities that may serve as predictors of dementia. Because highest scores on the tests are usually related to high educational levels, this aspect has been controlled, allowing the investigators to isolate changes in performance directly associated with age. By controlling for this factor such tests will generate fewer false-positives and thus more confidence may be placed on the assessment of dementia in specific populations.

Performance on every test decreased modestly with advancing age. Although English as a mother tongue is often considered very important in the results of such tests, it was found to be less important than either age or education.

Neither hypertension nor prior mild to moderate alcohol intake appears to be a significant contributor to these declines. By following the subsequent health of these subjects it was also determined that only a limited amount of the poorer performance of older persons could be explained by severe illness, impending death, or incipient dementia.

The main objectives of this research are to identify systematically the individuals who experience the greatest declines in cognitive functioning with age and to distinguish the possible causes for these declines (i.e., Alzheimer disease, multi-infarct dementia, depression, etc.). Such identification and categorization represents a necessary preliminary step to research on risk factors and causes related to these conditions. Although the search for risk factors has begun, the number of cases of each of the major kinds of dementing diseases is still small. However, since all participants are reevaluated biennially as a regular part of the Framingham Heart Study, the investigators are able to identify not only existing cases of dementia, but also new cases, their ages of onset, and rates of progression of the major dementing illnesses.

An important aspect of this study is that it allows all participants to be categorized as to the development of Alzheimer disease during their lifetimes, and as to the severity and time of onset of their disease The study also offers the opportunity to examine relationships between dementing diseases and a wealth of prior, concurrent, and subsequent events and characteristics. Information being generated by this contract is being added to the data archives for the Framingham Heart Study and will be available for ongoing research for many years to come.

Increases in Calcium Concentrations Boost Learning in Aged Rats

It is known that a variety of normal functions, critical to the life of brain cells, are controlled by calcium. Typically, calcium concentrations in the cell are maintained at a very low level, increasing only when the cell is stimulated and prepared to release key chemicals (neurotransmitters) to other cells or to other parts of the cell. At this point, it becomes crucial for calcium concentrations to increase temporarily.

Several studies of the aging brain have suggested that calcium activity decreases with aging, possibly compromising cell communications. At the same time,

studies of Alzheimer disease and its possible causes have consistently highlighted a drop in the activity of acetylcholine, one of several neurotransmitters that is partially influenced by calcium.

At the Burke Rehabilitation Center in White Plains, New York, scientists are building upon these earlier findings in their attempt to stimulate calcium concentrations and increase the synthesis and release of acetylcholine. Drs. Gary Gibson, John Blass, and their colleagues have discovered a close link between the drop in synthesis and release of acetylcholine in healthy aged rats and certain learning and memory problems. Since both synthesis and release of the neurotransmitter are dependent upon calcium concentrations, the investigators injected the rats with a drug which stimulated oxygen metabolism, increased calcium concentrations, and, in turn, improved old rats' performance on certain tests which involved learning.

Previous studies of possible drug treatments for Alzheimer disease have pursued a variety of approaches. Some investigators have attempted to increase acetylcholine synthesis indiscriminately in all cholinergic cells. Others are trying to prevent the otherwise fast breakdown of acetylcholine once it is synthesized. Still others hope to treat Alzheimer disease by influencing the target cells' ability to respond to acetylcholine. Finally, a group of investigators are focusing on possible means to increase the ability of the cell to produce acetylcholine only when it is needed. Dr. Gibson and his colleagues have found a means to selectively pinpoint the sites at which the neurotransmitter is released and to program its release when the cell is active. The investigators are hopeful that this approach will ultimately benefit Alzheimer patients by allowing treatment with a minimum of side effects.*

Forgetfulness Compared in Young and Old Volunteers

How often does the average person forget a name or a face or an unimportant detail of some event? For a young or middle-aged person, such an incident might go unnoticed or, at most, become the subject of an ageist joke about early "senility." For an older person, however, the slightest lapse of memory is often taken too seriously, making the person acutely aware of his or her own aging, and sometimes resulting in further memory problems.

In order to determine how people react to occasional forgetfulness, NIA grantees Drs. Eugene Lovelace and Paul Twohig at the University of Virginia in Charlottesville interviewed a group of approximately 50 individuals ranging in age from 54 to 85 years. The investigators asked the volunteers how frequently they forgot things, what kinds of things they forgot, and what kinds of memory aids (mnemonics) they used to guard against such failures.

Results of this study verified earlier work by other investigators in the field. In general, older people reported a greater tendency than younger people to forget and more frequent problems remembering a word while engaged in conversation or while performing an act. A significant percentage of the people interviewed made lists and wrote notes to themselves or jotted things they needed to remember on a calendar. This was particularly true of the better

*For information on more recent research on Alzheimer disease, write to NIA Information Center, RA/Alzheimer, 2209 Distribution Circle, Silver Spring, MD 20910

educated volunteers. Older subjects were less likely than younger subjects to try to remember things by using mind games, such as making up a rhyme or a story.

Dr. Lovelace's study is one of several supported by the NIA which attempts to examine subjects outside the laboratory, presenting them with real-life situations. For some time, research has shown that older persons have certain problems with memory. Studies like this one can indicate the severity of those problems and how people are affected by them in their daily lives.

Link Demonstrated Between High Blood Pressure and Memory Impairment

Two prevalent health problems in the elderly appear to be related. The first large-scale population-based studies of elderly individuals, entitled Established Populations for Epidemiologic Studies of the Elderly (EPESE), have demonstrated a link between one type of hypertension and memory function.

Early results are reported by NIA-supported investigator Dr. Robert B. Wallace and his colleagues at the University of Iowa, Iowa City. Memory tests conducted on a large, rural elderly population confirm the relationship between memory and hypertension that, until now, has been observed only in much smaller studies of younger adults. Subjects were read a list of 20 words and immediately asked to recall as many as possible. Significantly lower memory scores were found among both men and women with *diastolic* hypertension, but not those with isolated *systolic* hypertension (ISH). Systolic refers to the first number in a blood pressure reading, e.g., the 100 in a reading of "100 over 70." Diastolic refers to the second number in the reading. This condition, called "isolated systolic hypertension," is defined as a systolic blood pressure greater than 160 and a diastolic pressure lower than 90.

No relationship was found between the memory test scores and the use of antihypertensive medication or amount of physical activity.

Dr. Wallace warns that these findings do not necessarily imply a causal connection. Rather, some underlying process, either genetic or environmental, may be responsible for the development of these concurrent problems. Furthermore, the prevalence of both hypertension and cognitive decline tends to increase with age, compounding the problems associated with either condition.

These results point to the need for additional information about this relationship and demonstrate that large-scale studies using simple memory tests are indeed feasible.

Systolic Hypertension Becomes Major Focus of Research

In the United States, more than 3 million persons over age 60 have elevated systolic blood pressure together with normal diastolic blood pressure (ISH). Several epidemiologic studies have reported that persons with ISH are two to three times as likely as those without the disorder to die from stroke or other cardiovascular disease. An estimated 30,000 strokes occur each year among older persons with ISH, and the direct costs for these strokes (hospital and nursing home care) are estimated to be $1 billion. Stroke often leads to disability or death, and multiple strokes may result in multi-infarct dementia.

Acceptance of ISH as a risk factor for stroke or cardiovascular disease does not necessarily lead to the conclusion that antihypertensive treatment is desirable. There is uncertainty as to whether or not drug treatment reduces the risk of stroke or cardiovascular disease, and there are also concerns about the potential for drug toxicity and impairment in quality of life by treatment side effects in fragile older persons. Such drug risks might outweigh the benefits of any reduction in disability and death resulting from untreated ISH.

To determine the benefits and possible undesirable effects of lowering blood pressure in elderly patients with ISH, the NIA and the National Heart, Lung, and Blood Institute (NHLBI) are cosponsoring the Systolic Hypertension in the Elderly Program (SHEP). Phase I of this long-term clinical trial was a double-blind pilot study conducted on approximately 500 patients with ISH who were randomly assigned to either a treatment group or a placebo group. The major findings of the pilot study were as follows: Chlorthalidone (a diuretic) reduces systolic blood pressure in the elderly when used in a modest dosage of 25 milligrams per day; the adverse side effects of chlorthalidone were slight and manageable, cognitive function was not influenced by drug treatment; and elderly patients can be recruited and demonstrate a high level of compliance with treatment regimens.

Based on the results of this pilot study, a full-scale randomized trial was started in 1985. Its primary purpose is to provide definitive answers to questions posed in the pilot study. Seventeen clinical centers across the country and one coordinating center have been established to recruit and treat the patients. It is anticipated that to recruit 5,000 patients it will be necessary to screen approximately 250,000 people over age 60.

By drawing attention to a condition once believed to be a benign and even inevitable sign of aging, this study has the potential to prevent or delay thousands of cases of fatal and nonfatal stroke and other cardiovascular diseases.

In a related project, the NIA and the NHLBI have issued a request for research grant applications (RFA) on mechanisms responsible for age-related increases in blood pressure. Despite the general upward trend in blood pressure with age, there is marked variability in change of blood pressure among individuals, and some older persons exhibit no significant age-related increase throughout adult life even in the eighth and ninth decades. Epidemiologic studies have identified more than 20 nonindustrial societies in which there is little or no rise in blood pressure with aging and hypertension is virtually absent. These societies are very diverse in race, habitat, diet, and lifestyle. It has been repeatedly demonstrated that when subsets of these populations migrate or change to a more Westernized mode of life, age-related increase in blood pressure appears, indicating that they are not genetically protected from rising blood pressure. An improved understanding of the mechanisms responsible for rising blood pressure with age in certain societies might lead to preventive interventions.

Skeletal Muscles of Old Rats Adapt to Exercise

The ability to exercise strenuously decreases with aging as a result of waning cardiovascular strength, deconditioning, disease, and other factors. But scientists are finding evidence that the basic capacity to engage in mild to moderate exercise continues well into the later years.

In a recent study of exercising rats, NIA grantee Dr. John

Holloszy and his research group at the Washington University School of Medicine in St. Louis, Missouri, found that the respiratory capacity of skeletal muscles does not decline progressively with aging when exercise is performed throughout life. This capacity plays an important role in determining an animal's ability to engage in endurance exercise.

Dr. Holloszy's study compared the levels of mitochondrial enzymes present in the foreleg muscles of young and old rats following a swimming program in which the animals exercised for 3 hours each day, 5 days a week, beginning at 6 months of age. The enzymes are indicators of respiratory capacity, with higher levels linked to increased ability to perform. The scientists found that, following the exercise program the enzymes increased to about the same levels in the muscles of 9- and 24-month-old rats. Thus, if a lifelong exercise program has been adhered to, aging does not appear to affect adversely the muscles' respiratory capacity.

Vigorous Exercise Reduces Heart Disease Risk Factors

People who have high blood levels of insulin (the glucose-controlling hormone) and/or low-density lipoproteins (a type of cholesterol) have a higher than normal risk of developing coronary artery disease. In another study conducted at the Washington University School of Medicine in St. Louis, headed by Drs. John O. Holloszy and James M. Hagberg, a 6-month program of intense exercise reduced both of these risk factors in a group of healthy older men and women. The researchers' findings suggest that regular, vigorous exercise may help prevent heart disease, the major cause of death in people over 65.

Seven men and four women in their sixties completed a 1-year exercise program. During the first 6 months they engaged in low-intensity training consisting of moderately vigorous walking 4.6 times per week. Then they moved on to high-intensity training consisting of cycling, treadmill walking, or jogging at least three times a week. Six men and four women in the same age range who did not exercise served as controls. None of the 21 subjects had exercised regularly before the study.

The researchers analyzed blood levels of insulin and lipoproteins in all the volunteers at 6-month intervals. They also checked their weight status and maximum oxygen uptake, the best indicator of cardiovascular-respiratory fitness. The researchers found that low-intensity training reduced insulin levels in the exercisers following an oral dose of glucose. Insulin levels dropped even more during the period of high-intensity training. Although blood cholesterol levels did not change after the moderate exercise program, they did improve after vigorous training. Body weight among the exercisers did not change during the moderate training program, but a significant amount of weight was lost during the program of intense exercise.

This study indicates that a regular program of strenuous exercise can have a very favorable impact on insulin response to glucose and blood fat levels, as well as significantly improving general cardiovascular-respiratory fitness. However, it is important for people who have been inactive to consult a doctor before starting a vigorous exercise program to check for problems such as hidden heart disease and orthopedic abnormalities.

Two other studies by the same research group also yielded evidence that the health benefits of exercise extend into the later years. One study demonstrated that when men and women in

their early sixties increased their walking and other daily activities (without supervision), they improved cardiovascular-respiratory fitness, resting diastolic blood pressure, insulin sensitivity, and other health indicators. Another study of young and old athletes and sedentary men found evidence that regularly performed vigorous exercise can prevent the deterioration of glucose tolerance and insulin sensitivity that occurs with aging.

NIA Scientists Study Effect of Age on Heartbeat Rate

Normally, during coughing, physical exercise, and other types of body stress, the heart automatically begins to beat faster. This cardiac acceleration is an important part of the body's adaptation to stress. Previous studies comparing young and old men showed that the degree of cardiac acceleration during stress declined with aging. They did not demonstrate whether these declines were abrupt and therefore likely to be associated with disease or were gradual with aging. It was also not known whether women experienced the same declines.

At the NIA's Gerontology Research Center in Baltimore, Maryland, Dr. Jeanne Y. Wei, in collaboration with scientists at Beth Israel Hospital, Harvard Medical School, and the Veterans Administration Outpatient Clinic in Boston, studied age-related changes in heart acceleration in 220 healthy, active, community-living men and women ranging from 20 to 90 years of age. Their purpose was to establish a range of normal responses for men and women in different age groups. They measured response to cough, which is considered a good indicator of the heart's capacity to accelerate.

The subjects, mostly volunteers in the NIA's Baltimore Longitudinal Study of Aging, had passed thorough medical examinations to eliminate heart and other diseases. After resting for 15 minutes, they were instructed to cough forcefully three times, with a rest of about 3 seconds between each cough. After the third cough, the heart rate rose rapidly and consistently in every subject, a normal reaction to mild stress. Heartbeat rates were monitored and correlated with age for all subjects.

Dr. Wei and her colleagues found a continuous decline with aging in the peak heart rate. Heart rate increased about 29 beats per minute for those in their twenties. It was about 17 beats for volunteers in their fifties and about 7.6 for those 80 years of age and over. The elderly also took longer to reach peak response but there was very little change in rate of return to normal resting heartbeat rate. There was also a decreased variation in resting heartbeat rate with advancing age. No differences in responses were observed between men and women in each decade.

Resting heart rates before coughing ranged from 44 to 96 beats per minute and did not differ significantly with age. Thus, the differences in heart rate increase were not due to lower resting heart rates, but were actually related to aging. There were also no significant changes in resting heart rate between sessions in any subject.

The scientists also found an age-related increase in systolic blood pressure (the force of the heartbeat pushing blood into the vessels) but no significant change in diastolic level (the pressure when the heart is at rest between beats). However, for all ages, there was no significant correlation between blood pressure and peak heart rate.

This study establishes ranges of normal heart rate responses to stress for men and women across the age range. It also shows that

the heart's response to stress can be measured by a very simple test.

Dr. Wei and her colleagues postulate that the decreased variation in resting heart rates with advancing age and the decreased ability to raise heart rate may share a similar mechanism. Further studies may explain why many older people have these changes and such problems as dizziness and fainting upon rising.

Dr. Wei's findings are consistent with, and in fact confirm, the earlier work of other GRC investigators Drs. Edward Lakatta, Jerome Fleg, and Gary Gerstenblith on cardiac response to vigorous exercise in normal subjects across the age span. According to these scientists, in order to meet the demands of exercise, the heart rate of a young person increases, while actual heart size remains constant. On the other hand, in older people, during intense physical activity the heart muscle is less responsive to the hormones that are secreted in response to exercise and cause heart rate to increase. However, the older heart dilates and the stroke volume, or amount of blood forced from the heart with each beat, increases. This adaptive process of older adults means that cardiac output is maintained with age.

Zinc Supplements Adversely Affect Cholesterol Levels

The possibility that people who take supplements of the mineral zinc may be increasing their risk of heart disease is suggested by recent research at the University of New Mexico in Albuquerque. A group of researchers headed by Dr. James S. Goodwin found that blood levels of high-density lipoprotein (HDL), a form of cholesterol that appears to protect against heart disease, were lower in healthy older people who took zinc supplements than in those who did not. All of the subjects whose blood cholesterol was evaluated exercised regularly, a habit which is known to raise HDL levels. But in those who took zinc (even in small amounts), the beneficial effect of exercise on HDL cholesterol was blocked.

This finding is one of many resulting from a current NIA-supported study of nutrition and immune function in 300 healthy men and women over the age of 60.

Dr. Goodwin says this research calls into question the wisdom of self-treatment with vitamin and mineral preparations in general, and zinc in particular. Millions of people, many of whom are elderly, take supplements on a daily basis. Some of the preparations being sold contain amounts of vitamins and minerals that are consistent with the Recommended Dietary Allowances (RDA's). Others are megadoses that provide as much as 10 times the recommended levels. Fifty-nine percent of the volunteers in Dr. Goodwin's large-scale study take at least one vitamin and/or mineral supplement. At the beginning of the HDL sub-study, 27 percent were taking zinc in amounts ranging from 15 mg. per day (the RDA) to 52 mg.

After noting that zinc supplements negate the beneficial effects of exercise on HDL cholesterol, the investigators asked 22 of the volunteers who were taking more than 15 mg. of the mineral to stop doing so. Eight weeks after stopping the supplement, tests showed that their HDL levels had increased. The extent of the increase correlated with the individual's level of physical activity, with those who exercised the least showing very small increases in HDL and those who exercised the most showing the largest increases.

Although the mechanism by which zinc affects HDL cholesterol is unclear, Dr. Goodwin speculates that it centers on the ratio of zinc to another trace mineral, copper, in the body. Some studies have found that these two minerals interact with blood cholesterol levels. Supplementing with zinc may upset the body's natural mineral balance.

Dr. Goodwin points out that zinc supplements have been recommended for treating taste and smell disorders and acne, and for improving wound healing and sexual potency. Studies also have shown that zinc boosts immune function (the ability to resist disease) in older people. Despite these potential medical uses, there is no scientific rationale for the current widespread consumption of zinc supplements by healthy people. This study suggests, in fact, that the practice may be detrimental to health. Further research is needed to find out whether or not zinc supplementation increases the risk of cardiovascular disease.

Income and Living Arrangements Related to Dietary Habits of Older People

Low income is strongly related to poor dietary habits among the Nation's elderly people, but living arrangements also affect their food consumption patterns, according to a recent report by investigators receiving grant support from the NIA.

Dr. Maradee A. Davis of the University of California in San Francisco and her associates at the University of Texas in Austin analyzed the dietary practices of older adults in various types of living arrangements to find out which individuals have the highest risk of consuming low quality diets and might benefit most from nutrition programs and dietary counseling. The scientists used data collected in the first National Health and Nutrition Examination Survey (NHANES-I) conducted by the National Center for Health Statistics from 1971 to 1974. That survey obtained information on the nutritional and general health status of people in the United States aged 1 to 74.

Dr. Davis' study focused on information provided during that survey by 3,477 adults between the ages of 65 and 74. Data on their age, sex, economic status, and living arrangement were collected during a home interview. Then the participants visited the examination site where a dietitian asked them to recall everything they had eaten during a previous 24-hour period and how often they had consumed certain foods during the preceding 3 months.

A thorough analysis of the data showed that poverty is strongly related to poor nutrition among the elderly. However, the type of living arrangement also has a significant effect on food intake. The people in this study who had the best dietary habits were those who lived with a spouse. Older people who lived alone, with another relative, or with someone else had less adequate diets than those who lived with a spouse. This finding was particularly true for men. Women who live alone or with someone other than a spouse are better nourished than men in comparable situations, probably because women develop better shopping and cooking skills when they are young.

For men, being poor and living alone constitute a double jeopardy. Individuals in this category have the least adequate diets. Their intake of milk products, fruits, vegetables, meat, poultry, and fish is the lowest of any group. They are also more likely than others to get less than two-thirds of the Recommended Dietary Allowances (RDA's) for

protein, calcium, riboflavin, vitamins A and C, and other nutrients.

The study provided information about a variety of dietary practices. Diversity in the choice of foods was low for some people. Ten percent of the elderly people surveyed reported eating five or fewer different foods each day. However, no evidence was found that those who live alone limit their diets to easily prepared foods such as bread, cereal, and beverages (the so-called toast and tea syndrome). Bread accounted for 21 percent, and cereal for 5 percent, of the total foods consumed.

Thirty-five percent of the population surveyed had an average of fewer than one serving of milk and milk products each day; 20 percent ate fewer than one serving of meat and fish; 10 percent had fewer than one item from the fruit and vegetable category; and 7 percent averaged fewer than one serving of bread and cereal.

The two food groups most neglected by people with low incomes are the fruit and vegetable group and the meat, poultry, and fish group.

This is the first reported investigation of the relationship between living arrangements and dietary practices in older people. The information gained should assist health care workers in identifying segments of the elderly population whose nutritional needs are not being met.

New Insights Gained into Taste Mechanisms

"Food just doesn't taste as good as it did when I was younger."

This problem, often vocalized by older people, is not just a figment of the imagination or a result of increasing dissatisfaction with life in general. Scientists are finding that by old age most people have lost some of their taste acuity. Even greater losses occur in the capacity to perceive and identify odors. Smelling food is a large part of its enjoyment. Because of these decrements, many older people do not eat enough food to meet their nutritional needs. This, in turn, can lead to poor health.

Declining ability to taste and smell food is a part of normal aging. But for many older people the problem is compounded by disease or use of medications, both of which can adversely affect these senses. Among the diseases that can alter taste, smell, or both, are flu, liver disease, kidney failure, nervous disorders such as Parkinson's disease, endocrine problems such as diabetes and hypothyroidism, high blood pressure, asthma, cancer, and many others. Radiation therapy and drugs such as diuretics, anticoagulants, antihistamines, muscle relaxants, and antibiotics can affect the capacity to taste and smell. Nutritional deficiencies and overuse of vitamin and mineral supplements also can interfere with these senses.

With grant support from the NIA, Dr. Susan S. Schiffman of Duke University in Durham, North Carolina, is investigating the complex mechanisms by which taste and smell occur, and developing ways to help people who suffer losses.

Taste is transmitted through taste buds located on the tongue, lips, and cheeks, and on organs such as the pharynx, larynx, and esophagus. Each taste bud consists of about 50 cells arranged in a pear-shaped format. These cells have a lifespan of about 10 days and are constantly being replaced by new ones. This renewal process can be affected by nutritional and hormonal states, radiation, drugs, and age. Scientists have generally believed that only receptors on the cell surface were involved in taste perception. However, Dr. Schiffman

recently found evidence that sodium transport is directly involved in the perception of taste in both humans and rats. This means that flavor molecules actually enter cells that make up the taste buds.

Dr. Schiffman discovered the role of sodium transport in taste by conducting an experiment in which she placed the diuretic amiloride on the tongues of human volunteers (a harmless procedure) and then tested their ability to perceive a variety of flavors. Amiloride inhibits the transport of sodium ions, which carry taste components into cells. The diuretic did not affect the ability of the volunteers to taste bitter or sour flavors. But it did reduce the intensity of salty and sweet flavors. These results show that taste is perceived through a complex mechanism in which different taste components use different pathways to enter the cells that make up the taste buds. It is even probable that more components are involved in taste than just the four commonly identified ones—sweet, salty, bitter, and sour. If these various taste elements and their pathways can be mapped, it may be possible eventually to correct or treat the taste losses and malfunctions suffered by older people.

In the meantime, Dr. Schiffman says that people who have taste and smell disorders can do several things to improve the palatability of food. First, they can alternate bites of different foods. When several bites of the same food are taken, the flavor is stronger in the first bite than in the following ones. Secondly, food should be chewed thoroughly. Chewing breaks down food, allowing more molecules to interact with taste buds.

In another approach to the treatment of taste and smell losses, Dr. Schiffman is developing simulated flavor and odor enhancers that can be added to foods to increase their appeal. These additives are made by analyzing the taste and smell components of natural foods and then duplicating them in the laboratory. Additives could also be used to improve the appeal of bland, but nourishing, foods such as soybean products. Textured vegetable protein, for example, could be made to taste like ham or sausage by adding the desired flavor artificially. Dr. Schiffman is interested, too, in developing flavor-enhanced sauces that could be added to cooked meats and vegetables for a tastier meal.

Living Alone Does Not Lead to Isolation for Many Older People

During the course of a lifetime, a person faces certain changes and events that are stressful. It has been proposed that support from others may act as a "buffer" to protect the individual from the stress of retirement or the death of a loved one, for example. Research has suggested that this social support may help speed recovery after surgery, protect against depression, and even reduce physical symptoms brought on by grief.

At the University of Michigan's Institute for Social Research in Ann Arbor, NIA grantees Drs. Philip E. Converse and Duane Alwin are testing the idea that social support may also contribute to feelings of well-being. To do this, they are investigating the effects of living alone versus living with others. This is an important consideration since the number of older people living alone has been steadily increasing.

It is often assumed that individuals who live alone are socially isolated. However, initial results based on data from a 1978 national survey indicate that people who live alone actually may have more friends and more contact with those friends. Drs.

Converse and Alwin found that widowed men and women living alone are no less likely than those living with others to be in contact with relatives, friends, and neighbors. Rather than isolating individuals, living alone may encourage them to develop and maintain friendships.

The investigators also found little evidence that living alone adds to problems of adjustment and adaptation. With the exception of individuals who have never married and men who are separated from their wives, people who live alone seem to have positive attitudes about life. Thus support from friends may prevent living alone from being as psychologically harmful as previously thought.

Study of Housing Investigates "Life-Cycle Lock-In"

In 1982 there were an estimated 15.2 million households in this country headed by people age 65 or older. Many of these older people, especially the 70 percent who are homeowners, live in housing that may be inappropriate for their current needs and capabilities. A large number also reside in inner city neighborhoods where they may be frequent targets for crime. But despite reductions in family size, income, or physical health, relatively few older people move to more suitable housing. This phenomenon is known as life-cycle lock-in.

Dr. Sandra J. Newman and James Reschovsky from the Survey Research Center at the University of Michigan's Institute for Social Research in Ann Arbor, recently completed an NIA-funded study of the possible economic causes and consequences of lock-in. Using previously collected data on elderly and nonelderly households, they calculated the benefits and costs of moving.

Results indicated that, on the average, there can be significant benefits associated with moving for elderly homeowners. The costs of searching for other housing, however, seem to be the primary obstacle to such moves. The study suggests that search costs are higher for elderly than for younger people, in part because they tend to have poorer access to transportation, and possibly because they are in poorer health. Actual moving costs and costs of selling a home appeared to have little effect.

The study also examined a group of older people who rent housing. It appears that the majority of these people would not benefit economically from moving. Such individuals often enjoy sizable rent discounts because of long-term tenancy or pay smaller rents because of the low market value of the buildings they occupy. Thus, these renters may be reluctant to move, even if it would mean leaving large, unmanageable homes or unsafe neighborhoods.

The psychological costs of moving away from familiar neighborhoods and homes where families were raised are often identified as a major deterrent to moving. Dr. Newman and Mr. Reschovsky found that these costs have only a small negative effect, although they admit that this result may reflect their inability to assess such cost accurately.

The authors conclude that low and moderately priced housing should be provided for older people. They also suggest efforts to provide assistance to people who would benefit from moving.

Scientists Analyze Patterns of Retirement Migration

At the Center for Social Research in Aging at the University of Miami in Coral Gables, Florida, Dr. Charles Longino and his associates recently completed a 7-year study of migration patterns of older people. Funded by a grant from the NIA, the study

investigated the interstate moving habits of the over-60 population between 1975 and 1980, and then compared these to patterns from the preceding two decades. What they found might directly apply to providing adequate housing, transportation, health care facilities, and other necessary services for this age group.

One of the specific aims of the study was to test whether there were identifiable state-to-state migrations ("streams") of people 60 years of age and older from 1975 to 1980 and whether there are any identifiable differences over the past decades. Results show disproportionately large streams to a relatively small number of states: Florida, California, Arizona, and Texas. Changing migratory patterns are reflected in the fact that a smaller share of people are moving to California while Arizona is rapidly increasing its appeal.

Another finding of the study is that more retirees are moving greater distances than in previous decades. Additionally, these people are more economically independent than people who do not move. Conversely, aging people who make short, interstate moves typically are more financially dependent on family.

Another hypothesis borne out by Dr. Longino's research is that metropolitan-to-nonmetropolitan migrations have continued among retirees. His figures show that these retirees tend to be more independent than older people moving into cities.

Migration to sunbelt states has increased over the past three decades. People who migrate from New York, New Jersey, Pennsylvania, and Ohio favor Florida, which is still the number one state for retirees. North Carolina is becoming a rapidly growing and attractive alternative for many. California accepts a large migration from Illinois but, as mentioned above, Arizona is also becoming a popular destination. Arizona, Texas, Arkansas, and North Carolina have become particularly attractive to the elderly in recent years.

Reverse migration patterns seem to be a growing phenomenon. Older migrants who are widowed (mainly female), ill, or less financially independent are more apt to move back to their home state and to be closer to family. States such as Florida seem to benefit at both ends of this; people who move there are healthier, economically independent, and vital citizens; those who return home are the reverse. It must be remembered, however, that Florida still receives a substantially larger percentage of elderly people than it loses. New York, New Jersey, Ohio, and Pennsylvania are states receiving large numbers of return migrants from Florida. The study also shows that California is losing a great number of retirees who, in addition to the above-mentioned reasons, may find the cost of living too high.

Early Retirement is Influenced by Type of Occupation

New findings from a recent labor force analysis suggest that the type of work one has been engaged in may affect when one retires. Dr. Mark D. Hayward of the Battelle Memorial Institute in Seattle, Washington, reports that white collar workers and manual laborers are influenced by different factors when making early retirement decisions.

A survey of 15 million men revealed that those in what are called "primary sector" jobs—which require high cognitive ability and social skill and afford greater choice and flexibility—are more likely to retire before age 62 than men in "secondary sector" jobs—which are more physically or environmentally demanding. However, when those

in primary sector jobs decide to continue working, they remain in the labor force longer than those in secondary sector jobs.

Features of primary sector jobs that appear to increase the likelihood of early retirement are tenure, wages, compulsory retirement regulations, and employer-provided pension programs. Workers in these jobs report better health, better pension coverage, higher educational levels, and greater assets. No one attribute, however, stands out as the sole contributor to the likelihood of early retirement.

Manual laborers were less likely than their primary sector counterparts to give poor health as the reason for retirement. Dr. Hayward speculates that such workers, being less able to cope with the financial costs of health care after retirement, value the economic benefits of work. Secondary sector workers also may view leisure time as having negative connotations, and continue to work as a means of preserving self-esteem.

The study also finds that, among secondary sector employees, double pension coverage does not significantly increase the odds of retirement before age 62. This indicates that past research may have overestimated the pecuniary influence of pension benefits and challenges the notion that pensions may provide "avenues of escape" from unpleasant work environments. Age-eligibility criteria for pension benefits may play a role in early retirement decisions as well. Such findings could have important implications for formulating private pension policy and retirement incentives for older workers.

Psychosocial Risk Factors are Important Determinants of Health in Older Persons

While it has long been intuitively known that lifestyle factors are important to one's health, scientific evidence is accumulating which shows this to be true, not only among middle-aged but also among older people. Longitudinal research demonstrates that behavioral characteristics as well as aspects of social and psychological life are significantly related to the risk of disease and physical disability.

Such is the contention of NIA grantee Dr. George E. Kaplan, at the California Department of Health Services in Berkeley. The results are based on the well-known Alameda County study. In this study, 7,000 residents between the ages of 16 and 94 were followed between 1965 and 1983. Subjects were interviewed at 9-year intervals on measures of physical and psychosocial well-being to assess age-related changes associated with risk factors for mortality, morbidity, and functional disability.

Lifestyle practices such as smoking, physical inactivity, substantial deviation from ideal weight, and irregular eating habits were significantly associated with mortality, even among those over 70 years of age followed for 18 years. Unmarried individuals were at higher risk of death in the younger age groups, but this effect disappeared between 60 and 70 years of age. On the other hand, social isolation from friends and relatives was consistently associated with greater risk of death, even in the older age ranges. These findings provide strong evidence challenging the notion that those in the later years are a highly selected group for whom the usual risk factors do not apply.

The investigators also measured functional impairment caused by a chronic condition acquired during the study (e.g., diabetes, stroke, arthritis). Two factors—being unmarried and being depressed—were most frequently associated with risk of disability.

Dr. Kaplan asserts that the associations of psychosocial and behavioral risk factors are at least as strong as biological risk factors and serve as important determinants of health in old age. The study finds no evidence to support the statement that risk factors are unimportant for older people, as some have suggested. In fact, the results argue strongly against the notion that poor health and disability are the inevitable consequences of old age, and suggest the validity of preventive health interventions for all ages.

Analysis Shows that Increased Period of Chronic Illness Accompanies Longer Lifespan

NIA scientists have analyzed morbidity and mortality data from the National Center for Health Statistics and have found that the number of very old people is increasing rapidly, that chronic diseases will probably occupy a larger proportion of the lifespan, and that needs for medical care in later life are likely to increase substantially. This complex issue has immense implications for health care planning. As outlined by Dr. Edward Schneider, Deputy Director of the NIA, and Dr. Jacob Brody of the Epidemiology, Demography, and Biometry Program, NIA, any increase in the numbers of chronically ill older persons or any lengthening of the period of chronic illness will increase considerably the total costs for care for our society. Life expectancy has increased dramatically from about 48 years in 1900 to today's figures of approximately 71 for males and 78 for females. While this finding perhaps squares with popular thinking about old age and illness, it challenges the assertions of other more optimistic gerontologists who hypothesize that, although people may be living longer, the onset of serious illness is being pushed back until just before death.

The investigators point out that the mortality rate of persons over age 65 is decreasing faster than that of any other older age group. In addition, interviews with members of older populations during the past decade have revealed no substantial change in the percentage reporting poor health and no decline in morbidity and disability. If the percentage of the elderly who are in poor health remains the same or increases and the number of individuals at advanced ages continues to increase, more people will spend longer proportions of their lives afflicted with chronic diseases.

The only approach that can forestall these consequences of increased life expectancy is for substantial progress to be made in the prevention, treatment, and management of the common chronic diseases of aging.

Home Care Visits to Older People Viewed as a Useful Alternative to Hospital Visits

The traditional thrust of medical care has focused on acute illnesses. This emphasis, due in part to the dramatic onset and defined course of most acute diseases, has dictated clinical and research strategies directed at rapid diagnosis and cure.

As the population of this country grows older, however, the focus is shifting from acute, short-term illnesses to chronic and degenerative diseases. In an effort to explore the new approaches for patient care that this shift requires, Dr. Andrea Sankar, an NIA postdoctoral fellow at the University of Michigan's Institute of Gerontology in Ann Arbor, is examining the potential role of home care visits for patients with severe chronic diseases.

Dr. Sankar's work suggests that home visits can help identify situations in the patient's physical and social environment that may affect the course of the disease or its treatment. This is especially true for patients restricted to their homes by severe illnesses. Home visits can provide information on the patient's diet, drug intake, and family interactions which might not show up during the course of conventional examinations in a hospital or office setting, and may suggest changes in care not previously indicated. Home care visits also can help prevent unnecessary hospital visits.

This study also indicates that the home may play a role in the training of health professionals. During home visits, students have a unique opportunity to observe the complexities of not only chronic disease, but the aging process as well. Just as the hospital ward provides experience in the treatment of patients with acute illness, the home may provide experience in the care of patients with chronic diseases.

Studies Focus on Understanding, Treating, and Preventing Urinary Incontinence

Urinary incontinence—the involuntary loss of urine—affects at least 2 million older persons living at home and another one-half million living in long-term care facilities. For many of these people, incontinence is a social and personal problem as well as a medical one. Those affected often isolate themselves, refusing to leave home or see other people for fear of an "accident." Several NIA studies are looking at primarily healthy elderly individuals who are incontinent and at what can be done to treat or prevent incontinence.

At the University of California in San Francisco, Dr. Linda Mitteness and her colleagues have found that incontinence in the community goes largely untreated. This appears to be due to the fact that older people and the people who help them obtain medical care know little about the causes, consequences, and possibilities for treatment and cure.

In her interviews with a group of social service workers and apartment managers—professionals who seem to play a major role in older people's decisions to seek medical care—she found an alarming lack of understanding regarding the types of incontinence that plague older people, the various causes of the problem, and the likely benefits of such treatments as medications, behavioral management, exercises, surgery, and various prosthetic devices.

A second study, being conducted by NIA grantee Dr. Thelma Wells and her colleagues at the University of Michigan in Ann Arbor, may offer a solution to women who are incontinent or are at risk of developing urinary incontinence. This problem is especially common in women over age 65.

The two most common types of incontinence in women age 55 and over are: stress incontinence in which leakage occurs during physical exertion or when sneezing or coughing, and urge incontinence in which patients have a strong urge to urinate and are unable to hold urine long enough to reach a toilet. The latter form may be associated with neurological changes, and is also the type usually associated with older people, while stress incontinence has been thought to be equally common among older and younger women.

In a study which will ultimately involve 400 women with urinary incontinence, Dr. Wells hopes to show whether pelvic floor exercises can be used to control stress incontinence. The pelvic floor muscles extend from the

base of the spine to the pelvic bone and form a supporting framework as they encircle the urethra and bladder. Voluntary tightening and relaxing of these muscles can strengthen them and is often recommended for pregnant women as a means of conditioning the pelvic area which must support the weight of a growing fetus.

The Michigan investigators designed a two-phase study which will compare pelvic floor exercises with more common drug treatment. In the first phase, which is still in progress, women with incontinence—who currently range in age from 55 to 90 years—are interviewed about their urinary problems and undergo tests to determine the type of incontinence they have. Surprisingly, in this study more women have been diagnosed as suffering from stress incontinence than from urge incontinence. A majority of the women interviewed so far have had the problem for 10 or more years, and a majority had sought help for the condition in the past but did not receive treatment. Improving knowledge about the average age of onset of urinary incontinence and about the most common type found in older women will help guide healthcare providers who treat the condition and who design patient-education programs.

In the second phase, the study participants either receive a standard drug therapy for stress incontinence—phenylpropanolamine—or are instructed in the use of pelvic floor exercises. A majority of the women using the exercises report that the treatment has helped their condition, but definite conclusions cannot be drawn until more patients have completed this phase of the study. If it can be shown that these exercises can significantly strengthen the pelvic floor area, it may be possible not only to help thousands of women who now suffer from incontinence, but to prevent the problem in younger women who may develop it in the future.

Behavioral Therapy Reduces Urinary Incontinence

Scientists at the NIA's intramural Laboratory of Behavioral Sciences in Baltimore, Maryland, have been investigating the therapeutic effectiveness of a combination of physical therapies and behavioral training procedures in older patients affected by either stress incontinence, urge incontinence, or bladder hyperreflexia.

Of these three types of urinary incontinence, stress incontinence is the most prevalent form, affecting almost half of all women at some time during their lives. Patients with hyperreflexive bladders and urge incontinence often experience a problem when their bladders contract prematurely or suddenly and in an uncontrollable manner. By the time they realize this event has occurred, it is often too late to avoid wetting. This condition may occur as the result of a stroke or other cerebrovascular event, some other disease such as diabetes, or prostatectomy (removal or resection of the prostate gland in men). Usually the cause is unknown.

Laboratory investigators worked with 39 elderly women on an outpatient basis. Nineteen were identified as having stress incontinence; the remaining 20 had either bladder hyperreflexia or urge incontinence. Those patients with stress incontinence were initially placed on a habit-training program, which involved regular voiding at 2-hour intervals. Patients underwent one to eight sessions of biofeedback therapy. This involved visual feedback of bladder and sphincter pressures critical to the patients' learning exercises to strengthen their pelvic floor muscles. This

training helped them to avoid incontinence during periods of physical stress.

The 12 subjects with bladder hyperreflexia and the 8 with urge incontinence also began with behavioral interventions. In these patients, however, emphasis was placed on learning how to cope with the urge to void. Patients needed to learn how to inhibit their bladders voluntarily during the contraction stage to prevent bladder contractions and to use their sphincter and pelvic floor muscles to avoid leakage.

The patients with stress incontinence required an average of 3.5 training sessions to achieve some degree of urinary control. Overall they reduced their frequency of incontinent episodes by an average of 82 percent.

Patients with bladder hyperreflexia also improved significantly. Subjects showed an 85 percent overall improvement, with several becoming fully continent. The urge incontinent subjects fared even better, averaging a 94 percent decline in urge-related accidents.

Overall, about one-third of the patients achieved total continence following therapy. Equally impressive, more than half experienced no accidents or only one accident per week after treatment.

These encouraging results suggest that behavior therapy is an effective method for treating three major types of urinary incontinence in healthy, cognitively intact older people. Clinically, this procedure has the potential for significantly reducing the medical and social problems linked to this frustrating condition.

Five clinical trials of behavioral therapies in both institutionalized and community populations are under way in cooperation with the National Center for Nursing Research, NIH. In addition, the Institute's intramural program is extending its intervention studies to incontinent residents of a nursing home/chronic hospital facility at the Francis Scott Key Medical Center of the Johns Hopkins University in Baltimore, Maryland, in collaboration with the Health Care Financing Administration.

Study Probes Mechanism of Menopausal Hot Flashes

Hot flashes experienced by many women during their menopausal years are characterized by a sudden feeling of intense warmth throughout the upper part of the body, often accompanied by flushing of the neck and face and sweating. A cold, clammy sensation or chills may follow. Flashes vary in intensity, frequency, and duration within one person and among different individuals. They often cause discomfort, embarrassment, and loss of sleep. In many cases medical attention is needed.

With grant support from the NIA, Dr. Fredi Kronenberg and her associates at the Columbia University College of Physicians and Surgeons in New York are examining the physiological mechanisms that underlie hot flashes. If these mechanisms can be pinpointed, it may be possible to develop techniques for alleviating them other than by estrogen therapy, which may cause cancer of the uterine lining and other problems.

The investigators are closely monitoring menopausal women during hot flashes and intervening periods to obtain measurements of heart rate, finger blood flow, skin and internal temperatures, sweat rates, and blood hormone levels. They have obtained a much more detailed description of the dynamics of the physiological changes that occur during hot flashes than was previously available, and have

measured associated changes in the levels of various hormones.

Typically, an aura precedes the hot flash by several seconds. During this period, heart rate and finger blood flow begin to increase. Then there is a sensation that the flash is about to occur, and this is followed immediately by an increase in finger temperature of up to 6°C and sweating, a drop in skin temperature in areas of sweating such as the forehead and chest, and a subsequent drop in internal temperature of 0.1 to 0.6°C. Hot flashes are associated with a sharp rise in blood levels of the hormone epinephrine and a simultaneous decline in the hormone norepinephrine. An increase in circulating luteinizing hormone is associated with most hot flashes. There is also an elevation of blood neurotensin-like reactivity during a hot flash.

Progress has been made in understanding the way in which the body's hormonal, nervous, and temperature regulatory systems interact to initiate hot flashes. A low estrogen level is known to play a role. However, Dr. Kronenberg speculates that release of a different hormone triggers the flash, perhaps by acting on the hypothalamus, which is the body's center for temperature regulation. The search for such a hormone is currently under way.

The research team is also gathering epidemiological data so they can examine the influence of genetics, environment, diet, exercise, and other variables on the incidence, severity, and duration of hot flashes. They are currently analyzing more than 500 questionnaires that were completed by menopausal women.

Sexuality of Older Women Investigated

New evidence has emerged indicating that sexual pleasure among older women is not compromised over time. Similarly, menopause does not appear to alter significantly the sexual habits of aging women.

While myths prevail, not much is known about the sexuality of older females. It has been suggested that certain physiological changes that may occur during and after menopause—hot flashes, a decrease in vaginal lubrication, and a decrease in vaginal flexibility—can contribute to a decline in sexual satisfaction in older women.

Studies undertaken by Dr. Frances Purifoy at the NIA's GRC in Baltimore, Maryland, are providing evidence to the contrary. Dr. Purifoy interviewed 144 women of varying ages, all participants in the Institute's Baltimore Longitudinal Study of Aging (BLSA). The subjects were divided into three groups, older women aged 60–79 years, middle-aged women 40–59 years, and younger women aged 20–39 years.

Dr. Purifoy found that the majority of elderly women did report some decrease in sexual desire, degree of arousal, and frequency of or capacity for orgasm. In addition, 71 percent of the oldest group reported a decrease in vaginal lubrication, compared to 55 percent of the middle-aged and 13 percent of the younger women.

Despite these changes among the oldest females, almost three-fourths said they noticed little or no difference in sexual satisfaction over time. And, surprisingly, 82 percent reported that menopause had produced either a negligible effect or, in some instances, a positive effect on their sexuality. About one-fourth of the latter cited a decreased concern over menstruation or birth control as the reason behind this favorable change.

Although most of the older BLSA women underwent some physical

changes apparently related to menopause, their degree of sexual satisfaction did not drop off in most cases. Age also did not appear to have a marked effect upon their quality of sexual pleasure, according to the participants.

While these early findings are encouraging, birth-cohort differences may have influenced how these data were relayed to the investigator. For example, different generational expectations and attitudes about sexual habits may influence how the women report their experiences during an interview.

Reports of Bowel Problems Increase as Women Age

Intramural scientists Drs. Lon White and Jacob Brody of the NIA's EDB Program have analyzed information on bowel function obtained from 12,120 NHANES-I (first National Health and Nutrition Examination Survey) participants aged 30 to 72. Although concern about bowel function, constipation in particular, increased with advancing age, there was no clear trend toward a diminished frequency of defecation. A sex difference was observed, with women reporting a lesser frequency of bowel movements than men at all ages.

Reported use of pills and medicines also increased with advancing age and was greater for females than males. The use of pills or medicines for bowel problems was associated with the complaint of constipation but did not appear to be affected by marital status, physical activity, race, or education. Among women describing themselves as troubled by constipation, the age-specific prevalence of "regular" medication use increased from 12 percent at ages 35 to 44 to 26 percent at ages 65 to 74. Since excessive laxative use does occasionally precipitate or directly cause serious intestinal, renal, cardiac, and neurologic illness, this study suggests that a substantial number of older women might benefit from counseling directed at more appropriate use of such medications.

Basic Information on Older Adults Gathered

A resource book containing the first baseline, that is descriptive, data on 10,000 people over age 65 living in their own homes in three communities has been published. These data were gathered as part of an investigation of health, social issues, and aging by the NIA's EDB Program and investigators from Harvard University (Boston, Massachusetts), Yale University (New Haven, Connecticut), and the University of Iowa (Iowa City). This document includes basic charts giving prevalence data on many characteristics and health problems of older people. This is the first volume of an anticipated series; later volumes will interpret the information provided.

Data from this major study show that the vast majority of older persons show little decline in their ability to move around and function normally until they reach their eighties. The ability to walk a half mile, climb stairs, and do heavy work around the house without assistance is retained by the majority of people almost throughout life. Even after the eighties most people can continue to carry out these actions without assistance. Reports from the University of Iowa show that for all persons over 65, 79 percent of the men and 71 percent of the women can walk a half mile. Eighty percent of the men and 65 percent of the women interviewed by the Harvard researchers can walk a half mile, as can 83 percent of

the men and 68 percent of the women interviewed in the Yale study.

Similar information on hearing and vision, chronic diseases, depression, sleep patterns, and use of alcohol and drugs will help to establish baselines that will allow researchers to compare their own samples to population norms. Details of social functioning, using such measures as contacts with friends and family, presence or absence of a confidant, and religious affiliation, will also be reported.

New Studies Gather Valuable Data on the "Oldest Old"—Population Aged 85+

The number of persons over age 85—the oldest old—is growing more rapidly than any other segment of the American population. In 1980 they included 2.3 million people and by the year 2000 are expected to reach 4.9 million; by 2040, when the baby boom cohort reaches its ninth decade, the oldest old are expected to total 13 million.

Census data gathered from people over 85 years old have often been inaccurate in the past. This has been due in part to illiteracy, inhibitions about stating true age, and incorrect records of birth dates. Additionally, there have been no accurate studies of the health, education, income, and other general characteristics of this population.

NIA grantee Dr. Ira Rosenwaike, a demographer at the University of Pennsylvania in Philadelphia, has recently completed a series of studies in which he has re-evaluated existing Census data on this diverse population.

Among other things, Dr. Rosenwaike found that, although income of the extremely old is on the rise, it is unequally distributed. His data confirm two previous findings: that more very old women than men are dependent upon government programs and that women far outnumber men at the oldest ages. Although the number of chronically ill elderly persons in this age bracket is growing rapidly, there is a clear trend within the healthy segments of this population toward living independently for as long as possible. However, in geographic areas where there are large proportions of people over the age of 85, it is predictable that all aspects of life that involve health care provision and social services will be significantly affected.

As a result of these studies, Dr. Rosenwaike emphasizes that living longer does not necessarily mean living better. He is convinced, based upon his studies, that alternative community services will have to be developed for the great number of old people in our future communities. "Population growth through decreased mortality may not attract as much attention as the baby boom," according to Dr. Rosenwaike, but the justification for studying the extremely old lies in socioeconomic reality. Researchers and planners in gerontology will need to institute the necessary provisions for the tremendous growth of people over 85 years old which our society will continue to experience.

Understanding and Preventing Causes of Hip Fractures Become Major Research Priorities

Hip fractures are a major source of disability and death for older people. People over 65 account for 84 percent of the more than 200,000 hip fractures that occur each year in the United States. If no treatment or prevention advances are made, the number of hip fractures will increase sharply to more than 300,000 per year by the year 2000. Personal and societal consequences of hip

fractures include increased nursing home and hospital admissions, dependency on rehabilitation services and devices, restriction of daily activities, and emotional suffering.

Approximately one in five hip fracture victims dies of complications attributable to the fracture, and 1 year after a hip fracture, 20 percent of the surviving victims cannot walk. In the United States alone, the annual costs associated with hip fractures were estimated in 1984 to be over $7 billion.

Hip fractures are directly related to loss of bone strength caused by osteoporosis. Also, since hip fractures in older persons generally occur only after a fall, an increased risk of falling is an additional related cause of fractures.

For some time scientists have recognized the importance of understanding osteoporosis, and research projects continue to yield useful information about the causes, treatments, and prevention of this disorder. More recently, attention has been directed at the problem of falls and gait disorders as they relate to fractures. It is increasingly clear that osteoporosis alone is not the sole or even primary cause of most hip fractures. Victims must experience a trauma, usually a fall, in order to break a bone. For several years, the NIA has stepped up efforts to encourage and support research in the complex area of falls and gait disorders.

Some of the progress made in the last year in the areas of osteoporosis and falls/gait disorders is discussed below.

Osteoporosis. Osteoporosis is a degenerative bone disease affecting as many as 20 million Americans, most of them over 50 years of age. The disease results in brittle, fragile bones, especially among thin, white women.

At least two, and possibly more, subtypes of osteoporosis exist, according to NIA grantee Dr. B. Lawrence Riggs and associates at the Mayo Clinic in Rochester, Minnesota. Type I or "postmenopausal" osteoporosis is associated with estrogen deficiency in women and begins to show symptoms 10 to 15 years after menopause. Low, oral doses of estrogen are effective for slowing the rate of bone loss in at-risk women, and may prevent osteoporosis-related hip and wrist fractures. Estrogen replacement therapy has been shown to slow bone loss when begun as late as 6 years after menopause. Dr. Riggs and colleagues are evaluating the effects of treating patients with estrogen combined with progestin (another hormone), which may reduce the related risk of endometrial cancer.

Scientists speculate that the body's decreasing ability to absorb calcium contributes to Type II osteoporosis. This subtype occurs primarily in men and women over the age of 75 and, compared with Type I osteoporosis, results in more gradual bone loss. The effectiveness of calcitonin, a hormone that affects calcium metabolism, is being studied by Dr. Charles Chesnut III at the University of Washington General Clinical Research Center (GCRC) in Seattle. Dr. Chesnut's work is supported by the NIA and the Division of Research Resources, NIH.

Calcitonin appears to increase indirectly the amount of calcium absorbed from the diet and incorporated into bone. The hormone is one of several that control the natural formation of new bone and the breakdown of old. Regular doses of calcitonin given to postmenopausal women might lower their chance of developing osteoporosis, according to Dr. Chesnut. The hormone also seems to prevent postmenopausal

osteoporosis from worsening. On the basis of the University of Washington GCRC study and another study conducted at Brookhaven National Laboratory on Long Island, New York, the Food and Drug Administration recently approved calcitonin for treatment of patients with osteoporosis.

Vitamin K is another nutrient (besides calcium and vitamin D) that may be implicated in osteoporosis. Vitamin K is essential for the synthesis of osteocalcin, a protein with calcium-binding properties needed for the mineralization of bone. Under the direction of NIA grantee Dr. Paul M. Gallop at the Harvard University and Children's Hospital in Boston, researchers have discovered that Gla (gamma-carboxyglutamic acid), a component of osteocalcin, is excreted in the urine and may be a reliable indicator of vitamin K deficiency and the status of bone metabolism. The investigators hope to perfect a noninvasive method of detecting osteoporosis by measuring serum osteocalcin and urinary Gla.

The value of exercise for preventing bone loss in men has been demonstrated by a team of experts in Honolulu, Hawaii. NIA-supported researchers at Kuakini Medical Center found that strenuous exercises—jogging and racquetball, for example—performed at least once a week were related to higher bone mineral content. Dr. Richard Wasnich, Director of the Kuakini Center, is also studying the effectiveness of estrogen combined with thiazide, a diuretic used for the treatment of hypertension which also decreases the loss of calcium in the urine. Women who have received this combination treatment and men who have taken thiazide on a long-term basis for hypertension show beneficial effects of bone mineralization. Studies are continuing on the potential therapeutic value of this drug.

Other positive results in studies of exercise were achieved by NIA grantee Dr. Everett L. Smith and associates at the University of Wisconsin in Madison after a 3-year regimen of stretching, aerobics, and upper-body conditioning in women experiencing menopause. The Wisconsin team has observed seasonal changes in bone mass which may reaffirm the usefulness of sunlight in preventing weak bones. To what extent these changes in bone mass are attributed to variations in physical activity and diet brought about by the change of seasons is unknown at this time.

At the NIH Consensus Development Conference on Osteoporosis (held in April 1984), it was concluded that the National Research Council's current Recommended Dietary Allowance (RDA) for calcium of 800 mg. daily is too low, particularly for postmenopausal women and possibly for elderly men as well. The Consensus Panel recommended that an increase in calcium intake to 1,000 to 1,500 mg. a day beginning well before the menopause will reduce the incidence of osteoporosis in postmenopausal women. In addition, the Panel noted that normal levels of vitamin D are required for optimal calcium absorption. Persons who do not receive adequate daily sunlight exposure, such as those confined to home or to a nursing facility, are at special risk for vitamin D deficiency. The current RDA for vitamin D is 400 International Units daily.

Falls and Gait Disorders. Gait, balance, and posture are complex functions that are often altered by disease and aging processes. The relationship between gait disorders and falling episodes is unclear, and attempts by investigators to correlate various dysfunctions in the central nervous system with frequency of falls

have not produced precise conclusions.

For some time, it has been recognized that many older people, especially those who are infirm and homebound, lose lower extremity strength and experience a decline in gait speed and step size. Despite this recognition, the relationship of ankle-flexing ability and ankle and knee strength to risk of falling had not been thoroughly examined in older individuals. Now researchers at the Albert Einstein College of Medicine in Bronx, New York, participating in a Teaching Nursing Home project sponsored by the NIA, have conducted such studies in a group of nursing home residents.

Dr. Leslie Wolfson and colleagues studied muscle strength and flexing ability of the knees and ankles in two groups of nursing home residents. The 17 subjects in the study group ("fallers") had a history of one or more unexplained falls in the prior year; they were compared to 17 similar but non-falling control subjects. The participants were screened to eliminate those who had defined reasons for falling, such as previously diagnosed neurologic disease, severe arthritis, or severe vision problems. Four muscle groups in the knees and ankles were examined by the researchers. Compared to the non-fallers, the fallers were found to have a significant decrease in strength of the knees and ankles. Ankle-flexing ability in fallers was markedly diminished compared to non-fallers. Ankle neuromuscular dysfunction in the elderly faller may account for postural instability in general, and extreme loss of flexing ability may be particularly responsible for backwards falls.

These findings add to the small but increasing body of knowledge about the effects of specific physiological changes associated with older age and the risk of falling. The recognition of possible deficits in the neuromuscular components that control balance and gait could lead to the development of methods to strengthen and retrain coordinated function in this critical area.

In another effort to provide directions for future research on falls and gait disorders, the NIA sponsored a workshop in 1984 on the biological and behavioral aspects of falls in the elderly. In August 1985, the proceedings of this workshop were published in the *Clinics in Geriatric Medicine*. The papers published in this volume focus on the causes of falls and their contribution to injuries in older people. A better understanding of the causal factors involved in falls can lead to better ways of preventing such accidents. This publication should help stimulate new research projects that will ultimately lead to a more thorough understanding of falls.

In November 1985 the NIA issued a Request for Grant Applications on the topic of neurologic, muscular, perceptual, and cardiovascular aspects of falls and gait disorders in elderly people. Investigations being solicited include those that will identify both the physical factors and the underlying pathological or physiological mechanisms responsible for the various types of falls and disabling gait disorders common in older people. This invitation to the research community to focus attention on this important topic reflects the NIA's viewpoint that falling and gait disorders are not an inevitable accompaniment of old age, but are the result of diseases and potentially treatable conditions. Results from such research will help investigators design future clinical trials of interventions to prevent falls and gait disorders.

NIA Gathers Data on Groups Most at Risk for Hip Fractures

Using data from the National Center for Health Statistics, investigators Drs. Jacob Brody, Mary Farmer, and Lon White of the EDB Program of the NIA have examined age, race, and sex as they relate to hip fractures in Americans. Their study suggests that the roles of race and sex are more complex than generally supposed, since age-specific risks appear to be similar among black males, black females, and white males. White females appear to be at approximately twice the risk of the other groups at every age. Rates of hip fracture increase with advancing age in all groups at essentially the same rate. Controlling for age, scientists have found that white males, black males, and black females have comparable rates. Existing studies have shown that black males have greater bone density than either white males or black females, therefore it is reasonable to ask why black men have the same rate of hip fractures. Better measures of bone density would help to answer this question and research is needed to investigate the various biological, social, and environmental factors which influence the risk of hip fracture.

Debate continues on the most effective prevention strategy for such fractures. The results mentioned above are consistent with other data and with a widely accepted view that the osteoporotic process begins several years before increased risks for fracture become apparent. Strategies for prevention of fractures in later life may include improved diet and exercise begun as early as the second or third decade of life, and by consideration of mineral and hormonal supplements in the fourth or fifth decades. If such strategies resulted in a 5-year delay of the osteoporotic process, the anticipated result would be an approximate halving of the overall occurrence of hip fractures during later life.

Recent Evidence Shows Vitamin D Production Decreases With Age

While experts commonly assume that bone disease in older people is caused by osteoporosis, studies in recent years show that many persons with hip fractures actually have osteomalacia (also called adult rickets). Osteomalacia is characterized by a decrease in deposition of calcium salts in the protein matrix of bone, and is usually caused by inadequate vitamin D, due to inadequate vitamin intake or inadequate sun exposure. Symptoms are difficulty in walking, or an inability to walk, and pain in the bones. Prevention and treatment of osteomalacia involve increasing vitamin D in the body, either through exposure to sunlight or vitamin supplements.

Vitamin D is now added to dairy products and other foods, so one might expect that osteomalacia would not be common; yet it is reported to be a significant medical problem for older people. Some of the reasons for its prevalence include: economic constraints that prevent many older adults from eating balanced diets; a lactase deficiency that results in poor tolerance to dairy products (common in about 5 percent of whites, and in 60 percent of blacks and Asians); an inability of the intestines to absorb calcium; and too little sunlight which inhibits the production of vitamin D.

NIA grantee Dr. Michael Holick recently found unequivocal evidence for another possible reason for vitamin D deficiency, namely that the production of vitamin D decreases with age. At the Massachusetts Institute of Technology in Cambridge, Dr. Holick is examining the influence of age on the skin's

capacity to synthesize adequate quantities of vitamin D. The study is based on his earlier findings delineating the sequential steps through which vitamin D is produced (i.e., ultraviolet radiation partially converts 7-dehydrocholesterol, stored in the skin, to a previtamin D, and the previtamin D continues the conversion over several days to become vitamin D).

The ongoing study includes the participation of normal volunteers, ranging in age from 18 to 90. After entering a walk-in chamber equipped with fluorescent lamps, the volunteers are exposed to ultraviolet radiation over the entire body. Each receives from 1 to 3 minimal erythermal doses of radiation, or the equivalent of a mild sunburn. Blood samples are taken at regular intervals to evaluate the vitamin D present.

In a related study at the Massachusetts General Hospital in Boston, Dr. Holick evaluated the vitamin D blood levels in 150 elderly patients who had been admitted to the hospital with bone fractures. The effort was an attempt to identify whether a vitamin D deficiency represents a health problem for older people living in Boston. He found that more than half of the patients had a vitamin deficiency.

The results of these studies demonstrate for the first time that the aging process has a significant impact on the ability of the skin to produce vitamin D; the results additionally clarify the role of sun exposure in vitamin D nutrition.

From studies by others there is growing evidence that as people age their bodies become less able to convert vitamin D to its physiologically active form. Without sufficient amounts of this activated form of vitamin D, calcium absorption through the intestinal tract is greatly reduced.

In summary, the fact that large numbers of older people may be deficient in vitamin D probably contributes to the higher prevalence of osteomalacia and bone fractures in this group.

New Injectable Cement May Help Repair Broken Bones

Technical advances in one field of research often lead to advances in other, unrelated areas. Aerospace engineers have worked for years developing better materials from which to manufacture airplane parts, for example wings, which must be strong yet light. Healthy human bone must also be strong yet light, which led scientist Dr. Tobin Gerhart to the idea of transferring technology developed in aerospace research in order to make a material to be used in repairing broken bones.

At the Beth Israel Hospital and Harvard Medical School in Boston, Dr. Gerhart and his colleagues are experimenting with various mixes of collagen—the primary component of human bone—and gelatin to produce an injectable bone cement. Bone fractures are a leading cause of disability in older adults, and account for a high percentage of admissions to hospitals and nursing homes. These fractures are generally thought to be a consequence of osteoporosis, an age-related bone disorder. For many elderly, complications resulting from a long convalescence associated with a broken bone may cause permanent disability or even death. For these reasons, scientists are anxious to find better ways of repairing bone fractures in older patients, especially those with osteoporosis.

Laboratory evaluations of the compressive properties of Dr. Gerhart's collagen/gelatin composite have shown that it is as strong as porous human bone. The composite has the consistency of a semi-liquid paste suitable for injection into the bone

cavity when first mixed; after injection, the cement hardens to provide immediate structural support.

Successful development of a cement suitable for injection into human bone involves overcoming such problems as high body humidity and temperature, two factors that would have an obvious effect on the stability of the glue-like substance. The cement must also be biologically compatible, since it must eventually be resorbed and replaced by the host bone.

In addition to aiding patients with osteoporotic bones, the cement could be used to correct defects caused by tumors and infections, or as an alternative to methylmethacrylate, the synthetic material currently used in total-hip replacements.

Preliminary tests have been successfully conducted in sheep, but human studies have not yet been performed. The Boston research team plans to continue refining the cement to achieve better biocompatibility and strength, and plans to adapt the techniques used in animals for studies in humans.

New Scanner Detects Spinal Bone Loss

A more accurate measure of the aging skeletal system is being applied in investigations in the NIA's Baltimore Longitudinal Study of Aging (BLSA), being conducted at their Gerontology Research Center (GRC) in Baltimore, Maryland. Dual photon absorptiometry, an innovative, low-risk diagnostic procedure, is being used by Drs. Chris Plato and Jordan Tobin to study bone loss and mineral density in the lumbar vertebrae. (lower spine) of healthy men and women of various ages.

Previously, GRC scientists had looked at skeletal changes in the hand, primarily the second metacarpal bone. Their studies indicated that combined cortical thickness of this bone gradually decreases with age, from about age 40 on for most healthy individuals. The researchers also have looked at bone density of the ulna and radius (bones of the forearm) with X-rays, or single photon absorptiometry.

The new scanner allows the researchers to make direct, precise measurements of bone loss and mineral density in the second, third, and fourth lumbar vertebrae, where bone fractures and breakage frequently occur with advancing age. Scanning the spine, the analyzer measures directly the bone mineral content through the various layers of tissue. Once collected, information on bone loss and mineral density is analyzed, compared to normal controls, computerized, and recorded.

According to the GRC investigators, the procedure yields many advantages over other techniques used to assess bone changes. Most important from a health standpoint, it emits only about 30 millirems of radiation, or about the equivalent of a chest X-ray. It is painless, takes about 30 to 35 minutes, and has an error rate of only 2 to 3 percent.

It is already known that cortical (long) bone loss is accelerated after menopause. According to Dr. Plato, a main objective for using the dual photon scanner is to determine if trabecular (spongy) bone loss is also accelerated with menopause, and if so, why. Also, Drs. Plato and Tobin hope to relate their findings to other ongoing studies of BLSA subjects, focusing on diet, exercise, smoking habits, caffeine intake, and the use of certain medications. In addition, they plan to extend their study to include assessment of bone loss in

the head of the femur (thigh bone), an area prone to fracture in advanced osteoporosis.

Common Personality Characteristics Found Among Certain Patients Undergoing Coronary Angiography

In the United States each year, about one-half million people with a history of chest pain (angina) undergo a surgical procedure called coronary angiography. This involves threading a catheter from an artery in the arm or leg into the heart and taking X-rays of the arteries after injection of a special dye. It is the only way to diagnose coronary artery disease (CAD) conclusively and to determine if coronary artery bypass surgery is necessary. Most patients referred for this test have classical symptoms of CAD, yet recent studies show that 15–20 percent of them have undiseased arteries.

In an effort to develop ways to detect which patients are likely not to have CAD and therefore might avoid this surgery, Drs. Paul Costa, Bernard Engel, and other intramural scientists at the NIA's GRC in Baltimore, Maryland, examined the physical and psychological complaints of patients who had angiography. The investigators analyzed diaries kept by 83 men and women with an average age of 56 years who underwent coronary angiography. They also conducted psychological tests and took medical histories.

They found that patients who were free of CAD had more psychological and physical complaints than those with severe disease. They more often reported stabbing pain, dizziness, weakness, or palpitations and more frequently noted feeling angry, annoyed, tense, fearful, or anxious. They generally scored lower on tests of emotional stability and more often experienced chest pain not associated with exertion. Patients with significant disease tended to report more frequent anginal attacks, especially following walking or other exercise.

In the future, Drs. Costa, Engel, and their colleagues will investigate whether or not these findings hold true for patients reporting chest pain for the first time. They will also try to determine at which point in the diagnostic process these evaluations could be useful. The scientists conclude that it may be valuable for physicians to evaluate behavioral and personality characteristics of some patients with chest pain before doing angiography.

Studies Explain Why Lower Doses of Anesthetic Drugs Are Needed in Older People

It is well established that as people get older they generally require lower doses of anesthetics and other drugs. Doses of anesthetics which are safe and effective for younger persons can produce undesirable and sometimes dangerous side effects for older people, such as prolonged hospital recovery, heart attack, kidney failure, or even death. It has not been well understood, however, why smaller doses are required for older persons and often it is not known exactly what doses are the most safe and effective.

In a series of studies under way at the University of California in San Francisco and Stanford University School of Medicine in Palo Alto, NIA-supported scientists are uncovering some of the reasons for these additional risks and are developing safer procedures for administering anesthetics to older people.

Dr. E. I. Eger and his colleagues at the University of California in San Francisco are evaluating how age affects solubility in blood of all the potent inhaled

anesthetics. These investigators compared four groups of subjects including infants, children from 3 to 7 years old, young adults between the ages of 20 and 40, and people over 75.

Young adults displayed the highest anesthetic blood solubility, with reductions in the younger and older populations. In older people, solubility was reduced 10–15 percent compared to younger adults. Thus at least one of the reasons the elderly require smaller anesthetic doses is that they show a change in the blood solubility of anesthetics.

Dr. D. R. Stanski and his colleagues at Stanford University Medical Center studied how the injected anesthetic thiopental (Pentothal) is distributed through the blood stream to body tissues in different age groups and how some of these tissues respond to the drug. Thiopental is the drug most commonly used to induce anesthesia in surgical patients, after which inhaled anesthetics are used to maintain the anesthesia.

Blood flow in older people generally is diminished and this reduces the efficiency of transfer of anesthetics from the blood to other tissues. However, despite the reduced transfer efficiency, normal levels of anesthetics are reached in the brain and the heart. Dr. Stanski and his colleagues hypothesize that this is a result of the differential decrease in blood flow with aging. Since circulation is reduced to a considerably greater extent in organs such as the kidney and liver than in the heart and lungs, removal of anesthetic by the kidney and liver is reduced, leaving a greater percentage of anesthetic available for transfer to the brain and heart.

It has long been assumed that older people require lower doses of drugs because the human brain becomes more sensitive to drugs with age. Using electroencephalograms (EEG) and sophisticated computer techniques to relate blood levels of the anesthetic thiopental to induced changes in brain waves, Dr. Stanski and his colleagues were able to estimate the brain's sensitivity to this anesthetic. They found no change in brain sensitivity with aging.

Thus, although the older brain is not intrinsically more sensitive to anesthetics, age-related changes in blood flow increase the effects of thiopental.

Armed with more specific knowledge about how the body handles this substance with increasing age, the investigators are using computer simulations and other techniques to develop more scientifically based guidelines for its administration.

Older People May Not Require Forced Fluid Infusion During Aortic Reconstruction Surgery

Kidney malfunction or failure after surgery is more common in older adults, a group which already has age-related decreases in kidney function. It had been thought that scanty urination during surgery was associated with developing kidney malfunction, and many patients are infused with fluids to produce more urination during surgery to avoid this perceived problem.

This procedure has its own risks because the resulting increased fluid intake causes the heart to work harder, which could lead to heart attack or heart failure. However, it had always been assumed the procedure was necessary to prevent dangerous kidney malfunction or failure.

At the University of California in San Francisco, NIA grantee Dr. Michael F. Roizen and his colleagues assessed urine output in 137 aged patients during aortic reconstruction (heart) surgery and then compared urine output with kidney function in these patients during 7 days following

surgery. They found no correlation between urine flow during the surgery and subsequent kidney function in patients who were treated with fluids or drugs and those who were untreated. The investigators have concluded that the potentially hazardous procedure of infusing the patient with excess fluids or using certain drugs to produce urination during aortic reconstruction surgery is not necessary.

Since the main cause of illness or death following aortic reconstruction surgery is myocardial infarction (heart attack), this study should help reduce the incidence of this dangerous side effect of surgery. These findings also may have additional important implications if similar results are observed with other types of surgery.

New Long-Lived Cell Line Enables Study of DNA in Hybrid Cells

One way to investigate the complex phenomenon of human aging is to study the basic units of life—cells. The billions of cells that make up the human body live varying amounts of time. New ones are reproduced and old ones die in a continuous cycle throughout life. As certain organs or tissues age, the cells in them generally have a declining ability to reproduce themselves. Scientists assume that the aging process is due in part to the loss of division capacity in cells that normally are required to divide, such as epithelial cells of the skin or that line the intestinal tract, liver cells that regenerate the organ following damage, and immune system cells. On the other hand, sometimes old cells undergo changes that cause them to proliferate uncontrollably, resulting in cancer.

Ideally, studies to determine how and why the proliferative nature of old cells changes would be conducted in living people. Because of obvious practical and ethical constraints on such experimentation, scientists instead use cells that are obtained in very small quantities from human blood, blood vessels, skin, liver, and other tissues. These cells are cultured in laboratory dishes where they reproduce, doubling and redoubling their numbers for a limited time, and then "grow old" and die. During the brief lifespan of the culture, scientists can use it to study various aspects of cell aging.

However, there are several drawbacks to the usefulness of these cell cultures in certain types of studies. For example, most cultures are not available to investigators until the cells have completed 10 to 20 "population doublings," and 30 doublings are often required before enough material is available to work with. Inasmuch as cells are normally capable of achieving only 50 to 60 doublings before they die, it is difficult for scientists to obtain young cloned cell cultures that have special properties they wish to study

An answer to this problem was found by NIA grantee Dr. James R. Smith and his associates at Baylor College of Medicine in Houston, Texas They isolated a long-lived human cell line which will go through 100 or more population doublings, permitting many studies that could not have been done before.

Using the new cell line, the scientists then created a number of hybrid cells by fusing old cells with both young cells and cells that proliferate uncontrollably. The latter included tumor cells and cells induced by a virus or carcinogen to divide abnormally. They found that the hybrids respond as if they are "old." This means that the old cells contain factors which regulate cell proliferation, and senescence is

dominant over youth in these hybrids. The results indicate that limited division is a process which is programmed in the DNA of normal cells. In rare cases, it is possible to change this process so that cell division is abnormal (as in cells derived from tumors), but sometimes these changes can be corrected by hybridization with normal cells.

Dr. Smith and his research team plan to design future experiments to pinpoint the DNA in normal cells that limits cell division and to determine what controls and regulates that DNA. When those controls are found, scientists may be able to manipulate the division of cells selectively in living individuals. It might be possible to stop abnormal cells, such as those in tumors, from dividing, and to stimulate cell division in areas where it is desirable, such as the denuded patches inside blood vessels where atherosclerotic plaques develop. The formation of those plaques could then be averted.

Studies in Fruit Flies and Nematodes Probe Genetic Control of Aging Processes

The theory that heredity strongly influences longevity is widely accepted among scientists. However, there are many unanswered questions about how genes exert their influence on lifespan. For example, how many genes determine longevity? Is lifespan controlled by a few major ones or by a larger number of less important ones? Are these genes located on particular chromosomes? Can the genes that control longevity be pinpointed?

One way to approach these questions is to study the lifespans of lower organisms living under controlled conditions in laboratory settings. Fruit flies are ideal for such investigations because they have a short lifespan, permitting the study of many generations, and a relatively small number of genes.

With grant support from the NIA, Dr. Leo S. Luckinbill at Wayne State University in Detroit, Michigan, is making progress in determining how genes control lifespan in these insects. Dr. Luckinbill has succeeded in producing strains of the fruit fly that have a greatly enhanced lifespan. This has been accomplished by reproducing populations at an advanced age in life, favoring long-lived individuals and their progeny. By contrast, other fly strains, reproduced early in life, show normal life expectancy. This research shows that the selective breeding of fruit flies in old age postpones senescence and death.

Dr. Luckinbill also found that when long- and short-lived strains are crossed, they produce offspring with an intermediate longevity. This finding demonstrates that lifespan is under genetic control.

The fruit fly strains that have been developed during the course of this study will serve as valuable new tools for research on the ways in which genes determine longevity. Similar long-lived nematode mutants are being isolated by Dr. Thomas Johnson at the University of California in Irvine. Nematodes are small soil organisms which have a short lifespan and can easily be manipulated genetically. Future experiments will also try to identify the biochemical and physiological differences between short- and long-lived strains and to determine how specific genes are responsible for the variations.

Regulation of Gene Expression Studied by NIA Grantee

Each cell in the body contains all of a person's genes, but not every gene is active in every cell. Even genes that are "expressed" in a given cell may be active at certain times in the life cycle and

dormant at other times. One of the big questions in modern genetics is how cells know which proteins to make, when to make them, and how much to produce. How, in other words, is gene expression regulated?

A promising approach to understanding the regulation of gene expression is being pursued by NIA grantee Dr. Glenn C. Bewley at North Carolina State University in Raleigh. Using the fruit fly as a model, he is looking at the genetic system responsible for the production of an enzyme called catalase.

Dr. Bewley has located the gene that encodes catalase, and is searching for the genetic elements that control its expression. To "expose" the regulatory genes, he is inducing mutations that alter the regulation of catalase production in the fruit fly. These mutations are detected through changes in catalase levels. Using this technique, he has identified areas of DNA outside the catalase gene that influence its expression.

Dr. Bewley is also investigating the role of catalase in aging and longevity. Catalase protects cells against damage from oxygen free radicals, highly unstable chemicals produced during normal cell metabolism. If these free radicals are not neutralized by catalase or other antioxidants, they can damage cell membranes, proteins, fats, and DNA. Some researchers believe that deteriorative changes associated with old age result from an accumulation of damage by oxygen radicals. Conversely, some researchers attribute man's relatively long lifespan to the efficiency of his antioxidant systems.

Since there are no naturally occurring mutants that fail to produce catalase, scientists have been unable to evaluate fully its function. Dr. Bewley is inducing mutations in the catalase gene of fruit flies and isolating mutants that do not produce the enzyme. His work provides a unique opportunity to determine what effect the absence of catalase has on susceptibility to free radical damage and on lifespan.

Project Identifies Ways to Communicate Health Information to Older People

The best way to deliver health messages to older adults is to use multiple channels of communication including television, radio, newspapers, magazines, fact sheets, and professionals such as doctors, pharmacists, and nurses. There is a greater likelihood that older people will adopt good health practices if they receive health information frequently and from a variety of sources.

This is the major conclusion drawn from a market research study of aging and health promotion supported by the NIA, the Office of Disease Prevention and Health Promotion, the Administration on Aging, and the National Cancer Institute, all part of the U.S. Department of Health and Human Services. The project was conducted under a contract with SRA Technologies in Arlington, Virginia; Porter, Novelli and Associates in Washington, D.C.; and Juarez Associates in Los Angeles, California.

The project's goal was to determine how interested older people are in acquiring health information and whether or not they want, and are able, to make lifestyle changes to improve their health. The answer is an unqualified "yes." A report summarizing the study and its findings asserts that there is a definite need for health promotion among the elderly. It concludes that many older people are very interested in health, that they have the time to engage in healthful activities, and that they may be particularly responsive to health promotion.

There is increasing evidence that many health problems are associated with poor health habits such as smoking, nutritional excesses or deficiencies, lack of exercise, and misuse of medications. Ideally, good health habits should be formed early in life. But older people, too, are known to benefit from dietary changes, increased activity, smoking cessation, and other positive lifestyle changes.

The market research project consisted of three parts. First, the researchers reviewed the literature on six specific subjects: physical fitness and exercise, nutrition, prevention of accidental injuries, safe use of medications, smoking, and preventive health services. Second, 15 focus group discussions were held with older people to learn about their perceptions and concerns regarding health; to determine whether concerns vary according to age, socioeconomic level, retirement status, or ethnicity; and to identify areas in which more information is needed. Third, the investigators reviewed data on the media habits and the demographic characteristics of elderly Americans to get information about which channels of communications are most effective in reaching older audiences.

The report offers specific suggestions about preparing materials. They should be simply and clearly written and relevant to different economic and cultural groups. They should provide information about recommended procedures, such as high blood pressure checks and influenza immunizations, and note the availability of specific services. Caution should be used, however, so that the results of health promotion are not "overpromised."

A major public health education campaign for older people based on the results of this study is now being conducted by six Government agencies and the American Association of Retired Persons.*

Case Examples Shown to be More Effective than Statistics in Conveying Health Information

Recent research points to the effectiveness of imagery as a means of conveying important health information to older persons. The use of vivid illustrations and case examples greatly increases the impact of health promotion messages. NIA grantee Dr. Karen S. Rook at the University of California at Irvine finds this strategy to be especially relevant in reaching elderly persons who may have difficulty remembering abstract information.

In a review of the content of 49 health promotion brochures, Dr. Rook found that less than 2 percent of the publications cited case histories; information on how to modify health practices was present in only 12 percent; and advice on how to cope, or answers to anticipated questions, was provided in 16 percent of the brochures. On the other hand, more than 50 percent of the publications emphasized statistical information (abstract) on the magnitude of a health threat.

In further exploratory studies comparing the impact of case histories to abstract information, Dr. Rook has found vivid information to be a more persuasive method of communication among both younger and older women. Specifically, those women who were most apathetic about a potential health threat were most likely to be influenced by the vivid case history. The technique is also effective for younger persons who may perceive the information to be of little personal relevance. It is this

*For information on the Healthy Older People program, call (800) 336-4797 (or 429-9091 in the Washington, DC area)

population for whom early intervention is particularly important in preventing the consequences of degenerative diseases like osteoporosis.

The primary consideration in designing health education messages is to make the information as realistic and personally meaningful as possible. Dr. Rook also suggests that messages be realistic about what to expect—the good as well as the bad. She advises health educators to incorporate suggestions on how to cope with undesirable effects of the new behaviors.

Although the use of vivid messages enhances recall, its actual impact on health behaviors is still unclear. The results of these studies, however, provide guidelines for more effective communication of health research materials to target audiences.

Bereavement Studies Conducted by NIA Grantees

It has long been thought that the death of a spouse is the single most stressful event in a person's life, but there has been little in-depth research on this issue particularly as it applies to older people. In recent years the NIA has funded various studies dealing with bereavement as it affects the mental and physical health of the survivor. As reported in a prior report,* Dr. Knud Helsing contributed a large-scale study on this topic. Several other researchers have also delved into this area.

At the University of Southern California in Los Angeles, NIA grantee Dr. Larry Thompson has found that impairment of the bereaved spouse's physical and mental health may not be as severe or traumatic as previously thought. Although depression, anxiety, and social withdrawal are common in the months immediately following a loss, there is a significant recovery within 1 year in most cases. His study demonstrated, however, that more men than women died during the first year after a spouse's death. Furthermore, he found that better psychological adjustment existed in individuals who were outgoing and flexible and those in higher socioeconomic groups.

In a second NIA-supported study, the late Dr. Martin Faletti substantiated Dr. Thompson's findings by concluding that when a spouse died unexpectedly there was more likely to be deeper depression than when death was anticipated, but there was no significant difference 7 to 13 months later. Additionally, he found that the death of a spouse was followed by a period of loneliness, depression, and decline in health, but most of this subsided after 1 to 2 years.

In another NIA-supported project, Dr. Margaret Dimond, at the University of Utah in Salt Lake City, is studying factors that help elderly people adapt to the death of a spouse. She found that among the 18 percent who were still experiencing major depression, stress, and the inability to cope after 2 years, the common denominator was low self-esteem that existed prior to the loss. Poor self-image was likely to affect physical, emotional, and social functioning. Dr. Dimond further determined that loneliness was the most common and persistent problem related to bereavement, but equally important were difficulties in doing home repairs, preparing meals, balancing the checkbook, and other daily activities. She recommends that in order to help

*Information on Dr. Helsing's study appears in the NIA's *Special Report on Aging 1982*. For a copy of the report, write to NIA Information Center, Box RA/Helsing, 2209 Distribution Circle, Silver Spring, MD 20910.

bereaved older people we need to identify those individuals with low self-esteem and work to enhance a good self-image through self-help groups.

Other grantees are studying such topics as bereavement resulting from the loss of a child, sibling, or parent, as well as loss due to divorce.

As a result of these and future studies, social scientists may be able to develop techniques to reduce the length and intensity of the period of bereavement.

Human Factors Research Offers Practical Approaches to Everyday Problems of Older People

Opening a refrigerator door may not seem that difficult a task—unless you suffer from arthritis or the seal that holds the door closed is stronger than you are.

Soon, computers and robots may be available to assist people who struggle to do the many things normally taken for granted. While 95 percent of all elderly persons live in their own homes, many require some kind of assistance in order to cope or merely to do the things they have always done. For several years, the late Dr. Martin Faletti received an NIA grant to examine some of the problems that healthy older people, and older people with physical disabilities, might encounter when doing daily household tasks and routines.

Dr. Faletti and his colleagues at the Miami Jewish Home and Hospital for the Aged in Miami, Florida, looked at how Parkinson disease and other neuromuscular disorders can make a chore of something as simple as getting in and out of a chair, how arthritis can affect an older person's ability to make a meal, and how technology might address these and other problems.

Of course, many older people live with family members who can accommodate such simple needs. Those who live alone can hire home aides to help with cooking and cleaning, but such care is often expensive, if available. Dr. Faletti's research is being applied toward a full range of efficient affordable devices—from a comfortable chair that assists the person trying to stand to a robotic arm that can pour a cup of coffee or open a screw-top jar. Technology is even envisioned which someday might make a full meal.

Dr. Faletti's colleagues hope to move beyond the kitchen to other rooms in the house and to look at other types of household chores. They also hope to create the software to convert what is now a computer-based robotic system into a voice-activated one, and at the same time, to build in an emergency call system. This type of human factors research is designed to help keep older people active, independent, and out of institutions.

Older People Hear Better Using Touch

Thirty percent of the U.S. elderly population suffer from some form of hearing impairment. Of these, as many as one-half million people are so severely impaired that standard hearing aids and devices are of little or no help.

With grant support from the NIA, Dr. Frank Saunders and his colleagues at the Tacticon Corporation in San Rafael, California, have created a wearable tactile (touch) sensory aid that may eventually open up the world of sound to deaf and hearing-impaired individuals. Dr. Saunders received NIA funds under a National Institutes of Health mechanism which, for the first time, provides grants to small businesses (i.e., profit-making institutions).

Dr. Saunders' device consists of a 1½ inch-wide belt worn around

the waist. When the user puts the belt on, 16 active electrodes (small gold-plated rivets) sit against the abdomen. A 1¼ pound electronic device provides the power for the system and allows the user to control the intensity of the signal. The device is no larger than a portable cassette player and can be hooked to a belt or carried in a purse.

As a small microphone clipped to the lapel picks up sounds, they are converted into 20 microsecond pulses which play across the band of electrodes. Vowels, consonants, and words create distinct patterns that the user must learn to recognize. The sensations are subtle and not at all uncomfortable to the wearer.

Like other tactile devices, the belt allows users to participate in conversations, to be aware that others are speaking even across the room, and to "hear" the sounds made by a ringing phone, a doorbell, or an oncoming car. But Dr. Saunders' device is unique—and perhaps more attractive to elderly individuals—because it is portable and inconspicuous. It may also prove to be far more sensitive in discriminating sounds than any other aid or method currently available to the hearing impaired.

Because sounds are translated on the basis of their frequency, the belt may prove especially useful to elderly individuals with presbycusis. Presbycusis, the most prominent cause of hearing loss among the elderly, is characterized by a gradual decline in hearing ability, especially for high-pitched sound. Currently, there is no hearing aid which fully compensates for this type of loss.

Through the Small Business Innovative Research program, the NIA provided original support to Dr. Saunders to develop and refine a method for translating language and other sounds into signals and to develop a prototype for field testing.

A number of questions remain to be answered as the investigators proceed with their tests, not the least of which is how able and willing older individuals are to learn a "new language." Nonetheless, Dr. Saunders feels that the device offers immediate benefits as a way of discriminating sounds in the environment, and assisting elderly people who are already lip reading. Although lip reading is the most widely used natural form of hearing aid among older people, it requires a great deal of concentration. Less intense concentration would be needed if the belt were used as a backup system.

The impact of hearing problems on the quality of life in old age can hardly be underestimated. It can lead to difficulties in day-to-day reactions and social isolation. Tactile sensory devices may help improve the quality of life for some 13 million elderly Americans currently affected by hearing impairments.

NIA PUBLICATIONS

Alzheimer Disease/Senile Dementia

Alzheimer's Disease (task force report)

*Progress Report on Alzheimer Disease, Vol III

Q & A Alzheimer's Disease

Senility Myth or Madness? (Age Page)

*Senility Reconsidered (reprint from *Journal of the American Medical Assoc.*)

NIA Programs

National Institute on Aging (description of NIA activities and programs)

*Normal Human Aging The Baltimore Longitudinal Study of Aging

To Understand the Aging Process The Baltimore Longitudinal Study of Aging

Disease Prevention/Health Promotion

Age Pages (a collection of NIA Age Pages—individual titles listed in Age Pages section)

The Menopause Time of Life

A Winter Hazard for Older People Accidental Hypothermia

Geriatric Medicine

Perspectives on Geriatric Medicine

*Progress Report on Geriatric Medicine

Aging Research

*NIH Technology Assessment Conference—Evaluating the Elderly Patient (conference proceedings)

Miscellaneous

Age Words A Glossary on Health and Aging

Publications List

Age Pages

(A single brochure containing these fact sheets is also available—see Disease Prevention/Health Promotion section)

How We Age

Aging and Your Eyes

Foot Care for Older People (c,s)

Hearing and the Elderly

Minorities and How They Grow Old (s)

Sexuality in Later Life

Skin Getting the Wrinkles Out of Aging (s)

Taking Care of Your Teeth

Disorders and Diseases

Aging and Alcohol Abuse

Arthritis Advice (c)

Cancer Facts for People Over 50 (c)

Constipation (c)

Dealing with Diabetes (c)

Digestive Do's and Don'ts

High Blood Pressure A Common But Controllable Disorder (c)

Osteoporosis The Bone Thinner

Prostate Problems

Senility Myth or Madness?

Stroke Prevention and Treatment

Urinary Incontinence

What to do About Flu (c)

Health Promotion

Can Life Be Extended?

Don't Take it Easy—Exercise!

Safe Use of Medicines by Older People (c)

Smoking It's Never Too Late to Stop

Crime Prevention/Safety

Accidents and the Elderly (s)

Crime and the Elderly (s)

Health Quackery

Heat, Cold, and Being Old (s)

Safety Belt Sense

Medical Care

Considering Surgery?

Finding Good Medical Care

When You Need a Nursing Home

Who's Who in Health Care

Nutrition

Be Sensible About Salt

Dietary Supplements More is Not Always Better (c)

Hints for Shopping, Cooking, and Enjoying Meals

Nutrition A Lifelong Concern (c)

*Intended for Professional Audience
(c) Also Available in Chinese
(s) Also Available in Spanish

To order single copies of any of these publications, write to

[illegible] mation Center, 2209 Distribution Circle, Box RA, Silver Spring, MD 20910, or call (301) 495-3455.

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